

**A REPORT ON THE NIAGARA LIMESTONE QUARRIES  
OF DECATUR, FRANKLIN AND FAYETTE COUN-  
TIES, WITH REMARKS ON THE GEOLOGY OF  
THE MIDDLE AND UPPER SILURIAN  
ROCKS OF THESE AND NEIGH-  
BORING (RIPLEY, JENNINGS,  
BARTHOLOMEW AND  
SHELBY) COUNTIES.**

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**I. GENERAL INTRODUCTION.**

This report is a continuation of the one on the Middle and Upper Silurian rocks of Clark, Jefferson, Ripley, Jennings and southern Decatur counties, published in the twenty-first report of the Department of Geology. While the preceding report dealt, however, chiefly with the geological problems involved, especially with the question as to what demarcation of horizons in the Middle and Upper Silurian strata would be most valuable in a study of these rocks from a geological point of view, the present report is concerned chiefly with a study of the principal quarries opened up in these strata, and the purposes for which the stone found in these quarries have been found especially valuable.

And it is desired to state at the very start that the present report does not seek to give an account of every neighborhood quarry. Almost all, perhaps more than 95 per cent., of the stone shipped in the areas here under investigation is quarried in the neighborhood of Osgood, Westport, Harris City, St. Paul, New Point and Laurel. In comparison with these localities the output of all other localities is insignificant.

This does not signify that the limestone at other localities is not as valuable as that found at the localities just mentioned. Some quarries now scarcely worked or altogether abandoned are known to have

formerly produced great quantities of valuable stone. But various circumstances have contributed to make the working of these quarries no longer as profitable as was formerly the case.

In many cases the stone could be worked with profit while the workings were confined to the outer faces of a cliff or hillside. But as soon as the quarrying operations were carried deeper into the recesses of the hill the amount of clay and gravel which had to be removed in order to reach the valuable stone increased in quantity and materially reduced the profits of the investment. Moreover, on entering the hillside new strata would be exposed to view which were not encountered while the quarrying was confined to the lower parts of the hill or cliff. These strata, which came above the valuable building rock first exposed were often of no value themselves, and their removal entailed much expense. These quarries were usually abandoned as soon as the worthless rock exceeded more than five or six feet in thickness.

For a time most of the quarrying which was done in the areas here considered was carried on in spite of great inconveniences as regards shipping facilities. The stone was quarried at a distance from the railroad and was hauled by wagons over bad roads to the railway station.

As soon as the most enterprising companies secured switches connecting their quarries with the railroad the additional expense of double loading, once on the wagons and a second time on the cars, was avoided. The quarries not having these advantages were no longer able to compete with these companies unless they had unusual natural advantages. The chief quarries in the neighborhood of Os-good, Westport, Harris City, St. Paul and New Point all have switches running from the quarries to the railroad stations. Laurel is the only region of any consequence which does not have such connections, and its output would be greatly increased, to the advantage both of the quarries and of the railroad companies, if switch connections were established.

The fact is that Laurel possesses certain natural advantages which have enabled the quarries there to compete with the quarries elsewhere, even without the assistance of switches. These natural advantages consist in the fact that the valuable stone at Laurel is well exposed at many points so near the tops of the hills that considerable quarrying may be done without reaching sufficient poor overlying stone to materially interfere with the profits of the quarry. Moreover, most of the layers are so thin that while the Laurel stone is of no great value as a building stone, yet it is without a rival in the ease with which it is possible to secure there great quantities of stone of just

the right thickness for curbing, gutter stone and flagging stones. This natural advantage would be much emphasized if the Laurel district were placed on a par with other regions as to its shipping facilities.

In addition to the quarries just mentioned there are many neighborhood quarries which furnish just enough stone to supply the demands of the neighboring farmers and villages for cellar and foundation stone. Work is done at these quarries only spasmodically and their total output is small. In the course of time their history will probably be different. Some new line of railroad not foreseen will bring some of these quarries into prominence. But at present they have no great value. Many of these smaller quarries are however mentioned in the body of the report when they show some features of interest in studying the general distribution of the quarry rock in this part of the State.

#### VALUABLE COURSES OF STONE.

In last year's report the Upper Silurian rocks were divided into the following horizons, mentioning the upper horizons first:

<i>Niagara.</i>	{	Louisville limestone.
		Waldron shale.
		Laurel limestone.
		Osgood beds, including limestone and clayey shales.
<i>Clinton.</i>	{	Clinton limestone.

In the area here under investigation only one horizon furnishes stone which is of any value commercially when quarried on a large scale. This is the Laurel horizon. At the very top of the Osgood beds there is often a single layer of limestone which can be used for the same purposes as the Laurel limestone, but often it is of inferior quality, and in any event it forms only a very small part of the rock actually quarried.

The layer at the top of the Osgood beds is about 14 inches thick where it is most worked. Immediately below this layer of limestone is a shaly clay layer, usually about 15 to 24 inches thick, which is locally known as the soapstone bed and which marks the base of all the quarrying operations in this part of the State.

The Laurel limestone, which is the real source of supply for all the good limestone of this section, has a total thickness of about 45 feet. This does not mean a total thickness of 45 feet of serviceable stone. At various levels the Laurel limestone beds contain cherty nodules and even almost continuous cherty layers, which more or less vitiate

the usefulness of the stone. Moreover, different layers of the limestone free from chert vary considerably in their chemical constituents, some layers containing more argillaceous material than others. These more argillaceous layers are less white in color; they are softer and show the effects of wear sooner; they are more readily disintegrated by the ordinary processes of weathering, of heat and cold, than the purer layers of limestone, and are therefore of much less value where continually subjected to the influences of weathering.

The very same quarry, therefore, shows layers of the very best limestone, and also layers which are vitiated by the presence of chert or which are too soft and which disintegrate too readily for many kinds of work.

It is very easily possible to discriminate between the different grades of stone, even without the assistance of chemical analyses. The better layers of limestone always form the projecting ledges on the faces of cliffs in the neighborhood of the quarries. The softer, more readily disintegrated layers, however, form the recesses between the better layers. On the face of the cliff the softer layers have often worn back several feet; they have often disintegrated enough to change from apparently a fair quality of limestone to a series of cracked and shaly limestones, which crumble away readily under the blow of the hammer.

In quarries which have no cliff exposure the poorer layers are discovered as soon as the quarries are opened, because disintegration takes place not only on the sides of cliffs exposed to the air, but also under the surface of the ground where plentifully supplied with water. Therefore, as soon as the stone is uncovered in the processes of quarrying the poorer qualities of stone proclaim their character by being reduced to a mass of friable limestone material near their edges and just beneath their covering of clay or soil.

The frequency with which the different layers are traversed by cracks is also indicative of their wearing qualities when exposed to the influences of weathering and of rough usage under foot. The good layers will show relatively fewer cracks, while the poorer layers will be traversed by frequent and often quite adjacent cracks, the stone being often reduced to a sort of limestone shale.

Any quarry which has been opened for a number of years is likely to have a considerable dump pile where the irregular pieces of limestone are thrown. Usually quite a number of pieces of limestone accumulate which have by no means been discarded, but which have not yet been sold. In any large quarry there is practically no layer of limestone which is not represented by some slab, lying in some part of the

yard, and which has been quarried during some preceding season. Any stone which will not readily withstand the influences of weathering when exposed to the changes of weather in winter is not likely to resist changes of weather readily when exposed to changes of temperature and to differences of moisture when inserted in the walls of buildings, and still less when used for sidewalks, curbings, gutter stones or for exposed bridge work.

The fact is that quarrymen are well acquainted with the characteristics of the different layers exposed in their own quarries. An experienced quarryman will identify at sight any one of the many layers of limestone lying promiscuously in the quarry yard and give a very good estimate of its comparative value for any specified purpose. In the presence of a person who is not a possible purchaser he will express himself with great freedom. In the presence of a buyer, however, all the layers seem to grow in value.

When a large order of stone comes in, the inferior layers of stone are often placed in requisition to fill in the order in the stipulated time. It is this dishonesty on the part of the quarry owners which has done much to bring the limestone into bad repute when brought into competition with good stone from other localities. Usually the quarrymen deny all charges of dishonorable dealing in furnishing poorer stone, when the samples originally shown were of better quality, by saying that the buyers who were securing the stone were offering such pitiable prices that they had no right to expect a better quality of stone for the money which they were paying. Or, they argue that it was necessary to use the inferior quality of stone in order to fill the large order of stone which they had received within the stipulated time, which is often no doubt true; but this does not assist in establishing a good reputation for the stone from their quarry.

Several quarrymen whom I visited frankly declined to give me any information concerning their quarries, on the ground that it would not assist them in any way financially to have the true character of the various layers in their quarry known. In several cases they told me of cases in which they had filled orders partially by the use of inferior stone, and also of cases in which stone which they had supplied had proven unsatisfactory for similar reasons.

There is not the slightest doubt that sharp practices of this kind, no matter what the cause or motive, must place the quarry supplying the order in disrepute.

The presence of chert nodules does not necessarily interfere with the value of limestone layers if they occur only in small quantities and are not likely to split the rock when exposed to the influences of

weathering. The unequal expansion of chert and of the surrounding limestone will sometimes result in the parting of the rock along the plane occupied by the chert nodules.

The chief damage of the moderate presence of chert nodules in the limestone is to the cutting tools. Provided the stone is to be used for purposes which do not require further cutting after the stone has left the quarry, the damage to the cutting tools is confined to the operations at the quarry, and the expenses of broken tools is added to the other expenses of quarrying. To the purchaser the presence of chert offers, however, no inconvenience.

When, however, the stone is to be used for purposes which require further cutting after the stone has reached the hands of the purchaser the presence of chert nodules is often a serious additional and perhaps totally unexpected expense. Cherty layers of limestone, in other words, are not very suitable for cut stone.

#### COMPETITION WITH CEMENT.

The Laurel limestone occurs in such thin layers, and is so readily quarried into slabs of quite considerable area, that it has always been regarded as the natural stone for purposes of constructing sidewalks, street and gutter crossings, curb stones and gutter stones. Of late years it has, however, had a serious competitor in cement, the use of which has increased to a remarkable extent. While formerly the sidewalks of almost all the towns in western Ohio and in Indiana were chiefly constructed of the Laurel limestone or its Ohio equivalent, at present the use of cement has almost entirely superseded that of the limestone. Many reasons have contributed to this change. The cement is easily shipped from place to place in barrels, which are readily loaded and unloaded without the assistance of cranes or derricks. A much smaller weight of material requires shipping when cement is used. The sand and grouting used in connection with cement is usually readily obtained at the locality where the cement is to be used at very moderate expense. This is a great saving in the item of shipping expenses. Moreover, when a poor quality of limestone is shipped, owing to reasons mentioned in preceding paragraphs, the cement sidewalks, if well constructed, are found to be more even and more durable than the limestone slabs.

For quite a number of years after cement had become a serious competitor to the Laurel limestone for walks the limestone remained by far the most used material in western Ohio and in Indiana for curb and gutter stones. During the last few years cement has, however,

begun to be a serious competitor even for these uses. This is especially true in the residence parts of cities, where heavy hauling is not likely to be done, and where, therefore, the wheels of vehicles are not likely to cause serious damage.

In some of the larger towns it is now possible to find miles of curbing and gutter where cement has been used. The curbing and gutter is usually constructed at the same time. The grouting is put down solidly and heavily, there is no break between the curb and the gutter and the entire length of curbing and gutter is continuous around each square, cement not being used where the gutter crosses the street.

#### COMPETITION WITH IRON.

Formerly gutter crossings were largely constructed of limestone slabs. At present, and indeed for many years, cast-iron crossings have been used to a large extent. They are neater; they are much thinner, and therefore give a greater amount of space for the passage of water, when compared with slabs whose upper surfaces had no greater elevation above the bottom of the gutter. For similar reasons iron plates have taken the place of the limestone slabs, which were formerly more commonly used as coverings for gutters where these crossed over intersecting streets.

#### COMPETITION WITH IRON AND CEMENT.

One of the most recent fields in which limestone has been brought into competition with other materials has been in the construction of bridge piers. The heaviest slabs of limestone were formerly much in use, and they are still employed largely. Recently, however, piers have been constructed of large tubes of iron, which were subsequently filled with cement. This forms a structure as firm as solid stone.

Even in the case of bridge abutments in some cases tubes of iron filled with cement have furnished the main support of the bridge at either end. Behind these piers large slabs of limestone have been placed, and behind these slabs rough broken stone of all sorts has been packed, held together by the abundant use of cement. There is no doubt that in many cases this forms a perfectly satisfactory bridge backing.

In all of the preceding paragraphs it should be remembered that the term, Laurel limestone, does not mean the limestone found at Laurel as distinguished from the limestone in other localities in the field here under investigation. The same series of limestones which are found at Laurel are also found at Osgood, Westport, Harris City, St. Paul, New Point and other localities.

It is convenient to have some name which can be used to indicate the general class of white limestones which is found at all of the localities just named, and it is quite common to name a series of rocks after the name of some locality where they are very readily found. The choice of the locality, Laurel, as the region which should furnish the name for the general series of white limestones found in eastern Indiana was purely a matter of accident, and the expression, Laurel limestone, is only a general expression for all the limestones here specially considered.

#### FORM IN WHICH THE LAUREL LIMESTONE USUALLY OCCURS.

The Laurel limestone usually occurs in horizontal slabs which vary considerably in thickness, but the variation in thickness lies between rather narrow limits. In the region of Longwood, slabs an inch and a half, two inches and two inches and a half are very frequent, but these quarries are no longer run on a large scale. In the neighborhood of Laurel the slabs are usually four, five and six inches thick, but layers seven, eight and nine inches thick occur with sufficient frequency to enable the quarrymen to furnish stone also for purposes requiring heavier stone. Some thinner layers, two and three inches thick, also occur, but the characteristic stone at Laurel varies between four and six inches, with only occasional layers of greater or smaller thickness. At New Point the slabs vary chiefly between eight and ten inches, although some of the layers hang together sufficiently well to be quarried into 12 and 15-inch slabs. By a process of splitting or capping some of the layers can be separated into four-inch slabs. The quarries at St. Paul, Harris City, Westport and Osgood all show layers four inches thick. Layers five and six inches thick also occur. But seven, eight, nine and ten-inch layers are the characteristic layers at these quarries. Moreover, the different layers can be quarried out together more commonly than farther northeastward, so that slabs 12, 15, 18 and even 20 inches thick may be obtained. Occasionally slabs 23, 24 and 25 inches thick have been secured from certain layers in some of the quarries. It should be remembered, however, in the case of these much thicker slabs, that they in reality consist of a number of slabs that can be easily split or capped, and that they can not readily be subjected to great pressures parallel to the bedding. When used, however, in position where the pressure is vertical to the bedding these large slabs have proved very serviceable, requiring less handling and not demanding the use of as much cement or mortar in the construction of piers for bridges and other heavy work.



## USES TO WHICH THE LAUREL LIMESTONE IS PUT.

In the construction of buildings the thinner layers are used for window sills and window caps. The thicker layers make very good door sills and range stone. By range stone is meant the layer of dressed stone which is placed just beneath the brick of a brick building and which serves as a sort of protection to the underlying ordinary cellar stone. The range stone usually projects a short distance beyond the cellar stone and thus sheds the rain which during a storm runs down the walls of a building.

Medium-sized stone is used for ashlar. Ashlar is the name applied to the flat stone slabs which are placed in an upright position on the outer surface of the cellar stone of the better class of buildings. These slabs offer an additional protection against the rain to the cellar stone. It is customary to dress the exposed face of the ashlar, very much improving the appearance of this part of the building.

Heavy slabs are used for steps and large slabs are used for the broad slab which usually forms the top of a series of steps, furnishing a landing at the top of the steps and immediately in front of the doorway.

Fairly heavy slabs of considerable length and breadth are also in great demand for porticos and porches. For the foundation of ordinary houses the fragments rejected for other purposes on account of their insufficient size are used. This cellar-stone material is usually known to quarrymen as rubble.

Below the foundations of very heavy buildings very large and thick stone are usually placed to serve as a strong and broad foundation for the superstructure. These heavy stone are known as footings.

In the construction of jails, one or two slabs of limestone are sometimes used to form each side of the cell. These slabs must, of course, be of considerable size. Three or five of these slabs will completely surround the cell by walls in which it will be impossible for the prisoner to make any insertions, and from which he will be unable to make any removals without having the same readily discovered by the jail authorities.

Reference has already been made to the use of limestone slabs for sidewalks, street crossings, gutter crossings, curbing and gutter stone. Usually the thinner layers of stone are found to be of sufficient thickness for these purposes.

In the case of bridges, the very heaviest stones are used for pier footings, or the very heavy stones placed at the base of piers. Similar

heavy stones will be used for the construction of the piers themselves. Large, heavy, thick slabs are used as a capping to the piers, and as a support to the ends of the iron superstructure.

The very heaviest layers of limestone are used for bridge abutments. The heavy stone is usually placed in that part of the abutment which is exposed to the fury of the water during high freshets. Behind this outer surface of very heavy stone the backing of the abutment is placed. This consists usually of riprap and gudgeon, piled in closely and held together by cement. By gudgeon is meant the yellow, soft stone which is usually found forming the upper layers of any quarry, before the regular good quarry stone is reached. In the quarries in the area here under consideration the gudgeon consists usually of thin layers, two to four inches thick, which are likely to be more or less filled with chert or to be at least associated with chert.

The large four-inch slabs which are now occasionally placed behind the iron post or pillars of bridges on the abutment side, and behind which a backing of rubbish and cement is placed, have already been mentioned.

Heavy limestone is used for the bases of monuments, and thin layers are used as grave covers, directly over the caskets.

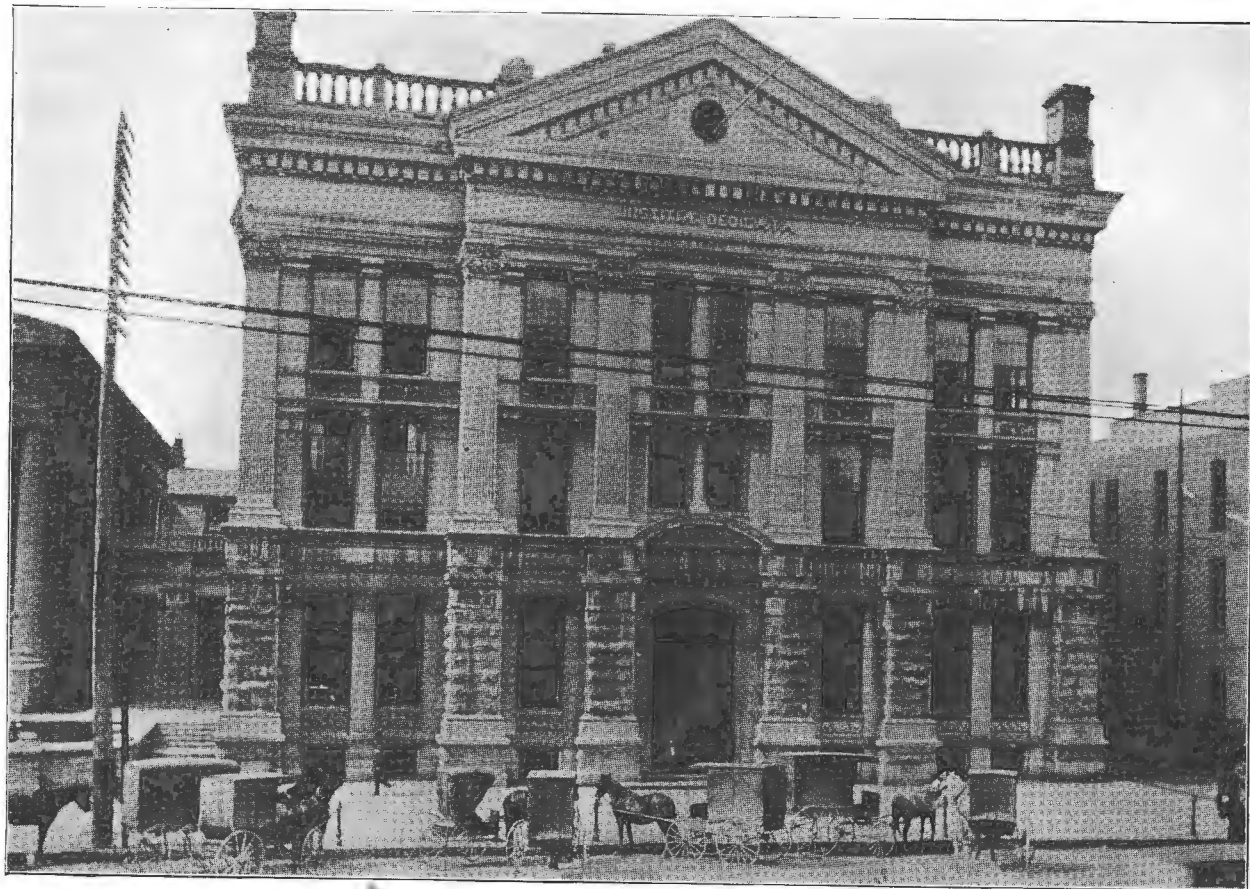
The heaviest layers are used in the construction of milk troughs and drinking troughs.

#### WHY THE LAUREL LIMESTONE IS ESPECIALLY USEFUL FOR THESE PURPOSES.

The Laurel limestone occurs in the quarry in the form of slabs of nearly uniform thickness in the same layer. Different layers, however, vary considerably in thickness, as has already been described. The upper and lower surfaces of these slabs are so nearly even that where no dressed work is required the stone is already sufficiently smooth on these two faces to be at once used. Even where it is desired to use dressed work the flatness of the upper and lower surfaces makes it necessary to do but little extra cutting there. Stone for almost any purpose can be therefore secured by selecting those layers in the vertical section in the quarry which have the proper thickness, and, after the stone has been quarried, the two faces in question are already trimmed by nature, altogether or nearly ready for use.

More than this, the quarryman may break out the stone slabs in such width that the stone will require scarcely any trimming around the margins of the slab, when being prepared for use.

It is readily seen that any stone which occurs in layers of all sizes,



COURT HOUSE AT DAYTON, OHIO.  
(Constructed of white Niagara limestone.)

as regards thickness, and which is already trimmed by nature on the two largest surfaces, can be quarried much more cheaply than a stone which is more massive, and which must be first split in order to reach these dimensions. For this reason the Laurel limestone will always be the pre-eminent stone for use in all cases in which it is desirable to use the stone in the form of slabs of greater or less dimensions. It may be crowded out in part by the cheaper cement, but in any case where it is desirable to use stone at all, the Laurel limestone will be cheaper to quarry, and it will be cheaper to work.

#### PURPOSES FOR WHICH THE LAUREL LIMESTONE IS NOT SUITABLE.

The Laurel limestone is a hard rock. It is not readily carved. This does not mean that it can not be carved at all. I have seen pillars of stone, equivalent to the Laurel limestone, which have been carved in the most delicate fashion, but it has been hard work. Of course the stone, when once carved, should retain the carved surface for a long time, but carving such a hard stone is too expensive, and for all purposes requiring carving the Laurel limestone will be always superseded by the Bedford limestone in Indiana, and by the Berea sandstone in Ohio.

#### THE USE OF LAUREL LIMESTONE FOR FINE ARCHITECTURAL CONSTRUCTIONS.

The value of the Laurel limestone for strictly architectural purposes has never been fully appreciated. I do not know of any striking use of the limestone in an architectural way in the entire State of Indiana. And yet it is a stone admitting of excellent architectural effects, when properly handled in conjunction with other materials. In order to justly appreciate the value of the Laurel limestone it is necessary to go to Dayton, Ohio, where the stone equivalent to the Laurel limestone is known under the name, the Dayton limestone.

Many of the most striking buildings recently erected in the city show the value of this stone when used in conjunction with other materials. This is especially true of some of the buildings in the resident portion of the city.

The Laurel limestone is a very white rock. This color is usually in strong contrast with that of any other rock. When used with taste, the white limestone does much to enliven the appearance of a building otherwise dull and gloomy in appearance. The white limestone usually offers good contrasts with the red color of bricks, and

is especially striking when used in combination with pressed bricks. It gives a very chaste appearance to a building in which the upper story is composed chiefly of light painted wood, the white limestone forming the lower part of the building.

Of course the limestone must be free from iron pyrites, or else the weathering of the pyrites will soon streak the walls of the building with the most unsightly streaks of brown. But this can readily be avoided. There are numerous quarries in the region here described in which certain layers are entirely free from pyrites. Quarrymen furnishing stone containing iron pyrites, when the contract has been for stone free from pyrites, and when they have been informed by the architects that the stone in question is to be used to produce special architectural effects, should have their names published as those of men to be avoided by the entire fraternity of architects; and those who furnish only good stone should be paid a price worthy of their labor and care.

#### METHODS OF QUARRYING IN USE.

The methods of quarrying in use in many of the quarries in the Laurel limestone are often very primitive. After the quarry has once been opened, holes are drilled by means of hand-drills a certain distance behind the front edge of the uppermost layer. Wedges are inserted in the holes thus formed, and a slab of a definite width is thus removed. The drill holes are placed in a row parallel to the front edge of the layer, closer together or farther apart, as experience directs the quarryman, the distance being determined by the hardness of the layer being worked.

The original length of the slab is usually determined by the presence of seams which traverse the limestone in approximately parallel directions. After the blocks of stone have been once loosened they are divided into such lengths as are considered desirable.

Some of the quarries at Osgood, Westport, Harris City, St. Paul and New Point have, however, introduced the use of steam drills, and of steam channelers. The channelers are used to cut deep grooves into the stone parallel to the face of the quarry, and also to cut similar grooves at the extreme right and left of the area quarried. The steam drills are then employed to divide the large blocks of stone thus blocked out into smaller pieces.

The methods employed are essentially the same as used in the workings of other quarries, and have been very well described in the report on the Bedford stone given in the Twenty-first Report of the Indiana Geological Survey.



RESIDENCE CONSTRUCTED OF WHITE NIAGARA LIMESTONE.

(Thick and thin courses.)

## II. A GENERAL ACCOUNT OF THE UPPER SILURIAN ROCKS IN THE COUNTIES CONSIDERED IN THIS REPORT.

In descending order the following Upper Silurian formations are found in eastern Indiana:

<i>Niagara</i> <i>Formation.</i>	{	Louisville limestone.
		Waldron clay.
		Laurel limestone.
		Osgood limestone and clay.
<i>Clinton</i> <i>Formation.</i>	}	Clinton limestone.

A brief account of the various formations is given in the following lines:

### THE CLINTON LIMESTONE.

The Clinton limestone of the more southern counties is quite fully described in the preceding report. North of New Point it varies in thickness from 5-6 feet, at St. Maurice and at Larkin Walter's quarry, to seven feet near the Cave Hollow Falls in Franklin County. At New Point the Clinton is less than 3 feet thick. A mile and a half directly east of Buena Vista and a short distance southward the Clinton is only 5 feet thick, and a mile west of this town it seems to be reduced to three and a half feet.

At Senior's quarry, south of Bull Town, the Clinton is 3 feet thick; at Bull Town it shows pebbles. Farther northward the following thicknesses are shown: At Derbyshire Falls,  $7\frac{1}{2}$  feet; three-quarters of a mile eastward,  $5\frac{1}{4}$  feet; at Chris Mead's quarry,  $6\frac{1}{2}$  feet; a short distance below Harrison Crowell's quarry, not quite 3 feet; an eighth of a mile below, or eastward,  $3\frac{1}{2}$  feet; at Harry Manley's quarry, 3 2-3 feet; at D. L. Sechrist's quarry, 3 feet; about a quarter of a mile eastward,  $3\frac{1}{2}$  feet; at D. L. Sechrist's quarry, north of Little Sain's Creek, a little over 2 feet; near John Deis's house it varies from nearly 2 to 2 2-3 feet; near John Bower's house it varies from 3 to 4 1-3 feet; at Daly Adams's, 4 1-3 feet; at Reiboldt's cave, 7 feet; at the Dry Branch quarry, only 1 foot.

In Fayette County, at church half a mile north of the county line, on Big Sain's Creek, it is 3 feet; at Huston's quarry,  $4\frac{1}{2}$  feet; at Ball's quarry, near Longwood, 4 feet.

As compared with the thickness of the Clinton at the nearest localities in Ohio the Clinton undoubtedly thins out westward.

The Clinton has no value as a building rock. It is considerably used in southern Ripley County as road material in the form of crushed stone. Where other material can not be obtained it is undoubtedly much better than sand or clayey gravel.

It has been suggested that the crushed Clinton might be used for grouting in case the cement works at Laurel were established.

#### THE OSGOOD BEDS.

A short distance east of the Alfred Ashman quarry, west of Osgood, the Osgood beds are well exposed on the north side of the stream, which heads in the quarry. About a foot at the base of the quarry is not exposed. Above this are 44 inches of clayey material, which farther northwest very much resembles the Madison rock, and which has sometimes been confused with the latter. Above this are 40 inches of clayey and rubbly limestone, such as is very characteristic of the upper half of the Osgood beds in this part of the State. Overlying this are several inches of clay; this clay layer is quite well known among quarrymen under the name of the soapstone bed. The soapstone bed usually forms the base of the quarries opened in the Laurel limestones. The reason for this lies in the fact that the top of the Osgood beds is usually formed by a limestone layer, which is of such good quality that it can be quarried with profit. Not infrequently this upper Osgood limestone layer proves treacherous when used for outside work, where the stone is required to withstand weathering, but for most inside work it is usually sufficiently lasting.

The soapstone layer forms the base of all the quarries worked along Sand Creek. The first layer above the soapstone rarely stands weathering, but is quarried for inside purposes. The total section of the Osgood beds is well shown at the Westport limestone quarry, where the basal layer is seen to consist of about 14 inches of fairly hard limestone. Overlying this are 46 inches of Madison-like clayey rock; then 66 inches of poor limestone; and finally, 14 inches of the so-called soapstone overlaid by the 14-inch limestone bed, which completes the Osgood section, and which is the lowest rock here quarried.

The lower Osgood beds were once quarried at the McGee quarry, but on account of their inferior quality their use was soon abandoned. A part of the Osgood section is well exposed down the creek from the Harris City quarry. Enough is seen to show that the section is essentially the same as that exposed at the Westport Limestone Company quarry.



The Osgood limestone was formerly quarried at the J. L. Scanlan quarry, near St. Paul, but this part of the quarry has been abandoned and the quarry hole has been filled up with water. The Osgood limestone is still worked in the more northern H. C. Adams quarry. The section does not closely resemble the Osgood sections of the Sand Creek region, but it presents features so closely similar to those of the New Point as to admit of their ready recognition. This similarity consists especially in the presence in the upper part of the Osgood section of limestone, which is so irregularly intercalated with clayey masses that the section appears more like a clayey rock, with irregular streaks and lenses of crinoidal limestone material. This stone will not withstand weathering at all. Its use has been abandoned in all parts of the State, except at the Scanlan quarry and at the New Point quarry. The usual thickness of this inferior clayey limestone is about 48 inches. Underlying the same should be about 5 feet of clayey shale, representing the basal portion of the Osgood section. The soapstone layer above the clayey limestone can not be recognized at this locality. The so-called soapstone of this locality belongs to a lower horizon.

The Osgood beds are well exposed at New Point. Lithologically they present the same streaky argillaceous layers between impure limestone layers, which have been already described as occurring at the St. Paul quarries. But in the case of the St. Paul quarries the horizon of the Osgood beds is not as satisfactorily determined as is the case at New Point, because at St. Paul the underlying Clinton is not exposed, and without the Clinton as a guide, the Osgood beds can not always be readily recognized when showing abnormal lithological features. The Osgood beds at New Point are about 11 feet thick. At locality 206, northeast of Larkin Walter's quarry, the Osgood beds are about 11 feet thick. The so-called soapstone layer, near the top of the formation, is here about 2 feet thick. At the Senior quarry, south of Bull Town, the Osgood beds are about 9 feet thick; the soapstone layer near the top is about  $1\frac{1}{2}$  feet thick. At the Derbyshire Falls the Osgood beds are about  $9\frac{1}{2}$  feet thick, including the limestone layer above the soapstone ledge. At D. L. Sechrist's lower quarry the Osgood beds are about 9 feet thick; the soapstone layer near the top of the beds is 20 inches thick. At Harrison Crowell's quarry the Osgood beds are about  $13\frac{1}{2}$  feet thick; the soapstone layer is seen. At Harry Manley's quarry the Osgood beds are 8 1-3 feet thick; the soapstone layer near the top is about 1 foot thick. At A. W. Cloud's quarry the Osgood beds are about 8 feet thick; the soapstone bed was not measured. At D. L. Sechrist's

quarry, north of Little Sain's Creek, the Osgood beds are 7 feet thick; the soapstone layer is 20 inches thick. At least 6 feet of rock assignable to the Osgood beds are seen at the Longwood quarries, but the total thickness is not known; nor is it certain whether the soapstone layer, which farther south is always found near the top of the Osgood beds, is here present.

The general characteristics of the Osgood beds as seen near Osgood consist of a series of clayey rocks, averaging about 10 feet in total thickness; overlying the clayey rocks is found a shaly soft clay, varying from 1 to 2 feet in thickness; above the clay or so-called soapstone layer are several layers of limestone, carrying the characteristic Osgood fauna. Aside from the abundance of fossils at this horizon the limestones at the top of the Osgood beds are often not to be distinguished from the limestone layers of the overlying Laurel beds. On going northward and northwestward from Laurel it becomes more and more difficult to distinguish the upper Osgood limestone beds from the lowest Laurel limestone beds. As a matter of fact, the shaley clay, or so-called soapstone layer, usually about a foot thick, which is found near the top of the Osgood beds, is usually the only indication that a horizon just beneath the top of the Osgood beds has been reached. In the entire Laurel region in western Franklin county, therefore, the soapstone is the only real indication that the top of the Osgood beds is near at hand. In the various sections of the quarried rocks in Franklin County the lowest layer of limestone just above the soapstone layer has been added to the Osgood section in order to make the Osgood section of these regions appear more in accord with those of more southern regions. The fact is that it is impossible to determine whether one, two or even three layers at the base of the good quarry rock should be added to the Osgood section in this region, since the Osgood beds cease to be richly fossiliferous northward, and the lithological distinctions are insufficient.

That portion of the Osgood beds below the soapstone is at present quarried at New Point.

I consider the stone, however, of very inferior value; I do not believe that it will stand weathering; and do not believe that it should be put upon the market. The fact that it is usually employed where it is not readily seen after it is embodied in the masonry does not recommend it for extensive use. Where exposed to the atmosphere it always weathers badly, and it is not to be considered good practice to place such stuff on the market.

The Osgood beds below the soapstone layer were formerly also worked in some of the quarries near Laurel. They are there known as the lower quarry rock. The rock was a miserable failure, and it

is quite amusing to note the explanations which are offered to account for its ready disintegration. For the stone soon becomes so disintegrated that it readily crumbles under the blow of the hammer. One season's exposure to frost and rain in the quarry yard is usually sufficient to spoil the sale of the rock. It seems that quite a number of years ago extensive operations were begun in this lower quarry rock. A part of these operations extended into the winter. Before the spring had arrived the stone was already useless. Indeed in some cases the stone could not be brought down to the railroad station within a short time after quarrying operations had begun if several strong frosts had intervened. Of course, the damage had been caused by the frosts, but the quarrymen believed that there was nothing the matter with the stone itself and that if it were quarried in summer weather it would harden and form a most serviceable stone. It is almost needless to say that this hope will never be realized.

#### THE LAUREL BEDS.

The line of railway running between Greensburg and North Vernon extends in a direction very nearly parallel to Sand Creek; thus affording excellent shipping facilities to the numerous quarries situated along the banks of the creek. Switches extend from the railway to the nearest quarries at Harris City, Westport and Sherwood Crossing. A few years ago quite a number of these quarries were in active operation, but at present only the quarries at Harris City, and those near Westport are doing enough business to warrant their special consideration.

These quarries are all opened in the Laurel limestone. At their very base, however, are found one or two layers of limestone which are lithologically similar to the Laurel, so as not to be distinguishable from the same, but which, nevertheless, must be assigned to the next lower horizon, that of the Osgood beds. The evidence upon which this is done is found in the more southeastern exposures of the Osgood beds, where this upper layer is readily distinguishable from the overlying Laurel limestone, and contains a very abundant fauna, such as is generally characteristic of the Osgood beds. This upper layer of the Osgood is also quarried, and is the lowest layer ever worked in the Sand Creek quarries. Sometimes it is a fairly hard limestone, but more commonly it is a somewhat softer stone than the overlying layers, notwithstanding the influences of weathering so well, so that it can not be used with perfect safety for outside work, while

still quite satisfactory for all purposes where the stone is not exposed to extremes of temperature. It is frequently of a blue color, and is locally known as the soft blue limestone bed.

Underlying this topmost member of the Osgood formation is a soft clay layer, which is usually called the "soapstone ledge" by the quarrymen. The soapstone forms the base of all the quarries along Sand Creek. It will therefore be made the starting point of all the measurements recorded in the following lines:

Three and a half feet above the soapstone there is usually in the Sand Creek area a layer which breaks up readily into thin pieces, especially after weathering a little; it is called the flawed or the fraud ledge.

About 5 feet above the soapstone is a very good ledge of stone with a fairly even surface, known as the regular ledge. Between it and the flawed ledge is another, known as the hard ledge. These terms are sufficiently explanatory in themselves.

The 6 or 7 feet of stone immediately above the soapstone are usually free of chert, and taken all in all constitute the best stone of the quarry. The 4 feet of stone overlying this part of the section, commonly contain more or less chert, and therefore can not be very well used for work requiring considerable dressing. Some of the layers naturally contain more chert than others. One of these, about 8 feet above the soapstone, contains so much chert that it is locally known as the black diamond ledge.

The rock above the chert, that is, above the level of 10 or 11 feet above the soapstone, is usually comparatively free from chert. It is, therefore, extensively used for dressed work. About 16 feet above the soapstone one of these layers is uniformly of such thickness and of such superior quality that it is used for the best kinds of dressed work. It has received on this account the special name, "the milk-trough ledge."

About 18 or 20 feet above the soapstone the layers of rock cease to be readily separable. The rock is usually densely crinoidal and somewhat more coarse grained than the layers below. It not infrequently contains little black nodular masses, which are very hard to cut with the quarry tools. Iron pyrites are often found. It is so hard to work that it is used only for the roughest kind of work, such as cellar stones and the like. These layers of stone are known as the iron ledges. They usually have a total thickness of 6 or 7 feet. They form the least desirable part of the quarry, and their presence is rather a nuisance than a help.

Some of the quarries contain stone even higher up than the iron ledges, but this stone is the one used for footings, and other heavy work, and occasionally for a poor grade of curbing. About 28 feet above the soapstone some chert is found.

The Harris City and Layton quarries include the iron ledges. McGee's quarry extends about 5 feet above the iron ledges. The quarry of the Westport Limestone Company does not quite reach the milk-trough ledge, but the quarries of the neighboring companies extend as far as the iron ledges.

The quarries at Osgood do not include such a great vertical section as most of the quarries in the Sand Creek region. The top of the Alfred Ashman quarry is at least 2 feet below the level of the milk-trough ledge. The chert comes in at very much the same level as in the Sand Creek quarries.

The Wagner quarry, south of Osgood, with its vertical section of only  $7\frac{1}{2}$  feet, extends only a foot above the level of the base of the chert layers, as exposed in the other quarries just described. This accounts for the remarkable freedom of the stone in this quarry from chert, a feature which is at once remarked by any observer accustomed to the frequent layers of chert in most other quarries of western Ripley and Decatur Counties.

The Laurel limestone in the vicinity of Laurel, in Franklin County, is sufficiently described in the body of this report to make any detailed description here unnecessary. Near the base of the Upper Quarry rock, immediately overlying the soapstone layer are found two or three layers of stone which are known to the quarrymen as the underground ledges. They do not consist of the best qualities of stone, and are usually used only for a lower grade of curbing. These underground ledges occupy the horizon just above the soapstone layer, a position usually occupied by the limestone beds at the very top of the Osgood beds in more southern localities. It is very probable that the underground beds, therefore, form in reality the top of the Osgood beds, and are to be assigned to these beds wherever they can be identified. The underground beds are usually only 10 to 15 inches thick.

About 3 or 4 feet above the soapstone layer is a layer which is known as "the spotted calf." The name is derived from the quite general presence in this layer of little chert nodules, which do not altogether interfere with its value as a mercantile product. In fact, where not much dressing is required it is a very useful stone. The very best stone in the quarry is found between the underground and the spotted calf layers. All of the stone can be used for the highest grade work.

The 3 or 4 feet of stone above the spotted calf layer are also of considerable value, but chiefly for flagging, street crossings, cellar stone and similar work. For dressed stone it is not so serviceable; the presence of chert in some of the layers being especially detrimental when stone is desired for dressed work.

Farther up chert becomes quite frequent, and the layers are often thin and much traversed by vertical seams.

#### THE WALDRON SHALE.

The Waldron shale is quite typically exposed at the Tunnel Mill, south of old Vernon. It is here chiefly a clayey shale exposure. On going northward the shale contains a greater proportion of limestone elements. In the neighborhood of Sandusky, at the famous fossil locality, on Conn's Fork, south of Waldron, at the George Wright locality, and at the Mary Wurtz locality, on Flat Rock Creek, and at several of the localities near Hartsville, the Waldron shale contains irregular, almost nodular, masses of limestone, which are often very fossiliferous. These irregular limestone masses are often of considerable size; some of them are 4 or 5 feet long and 1 or 2 feet thick. Usually, however, they are only about 24 to 30 inches long. The presence of these limestone masses is only another instance of a tendency which seems to be quite general in the Middle and Upper Silurian sections of this part of the State, i. e., that the corresponding rocks grow more calcareous to the northwestward. This tendency is naturally more readily detected in the case of the more shaly courses of the sections.

The tendency of the Waldron shale to become more calcareous on going northward in the State is also shown by the fact that at the localities east of Sandusky the lower part of the Waldron shale section contains a considerable amount of limestone in the form of very thin limestone courses, while still farther north the horizon of the Waldron shale is only marked by the abundant appearance of its characteristic fossils, the matrix in which these fossils appear being, however, a limestone, and the shaly character of the formation having entirely disappeared.

#### THE LOUISVILLE LIMESTONE.

The Louisville limestone is well exposed on Conn's Creek, south of Waldron. It is quarried at William Avery's quarry, and is a very serviceable stone for the region in which it is found. It has been found very difficult to determine the line between the top of the Louisville limestone and the bottom of the Devonian at any locality

far north of the Ohio River in the area here investigated. The Louisville limestone is not fossiliferous in most of the exposures from Vernon northward. In the few localities where fossils have been found, it has been impossible to determine the species with sufficient accuracy, and to find the fossils over a sufficient vertical distribution to make it possible to assign any appreciable thickness of limestone over the Waldron shale to the Louisville limestone. Most of the fossils that have been found have occurred just above the Waldron shale.

In the same manner the lowest fossils which could with certainty be identified with fossils from Devonian horizons have usually occurred about 25 or 30 feet above the Waldron shale. This is true of most of the localities near Vernon, in Jennings County, and near Hartsville, in Bartholomew County. In several localities south of Hartsville, however, especially at Long's Falls, it has seemed possible to refer certain fossils found within 5 feet of the Waldron shale to the Devonian fauna. Now, at William Avery's quarry, and at several other localities along Conn's Creek, farther southward, it is possible to observe a distinct unconformity between the layers here assigned to the Louisville limestone, and the beds, which with almost equal certainty are assigned to the Devonian. The degree of this unconformity is at no point very great. It is best seen at the Avery quarry itself, where it was first noticed. But the unconformity is believed to be sufficiently extended to account for the close proximity of Devonian fossils to the Waldron shale in the neighborhood of Long's Falls, near Hartsville, and the much greater thickness of the Louisville beds in the southern part of the State. Unfortunately the writer has made most of his studies on the Middle Silurian rocks of the State, and upon the Laurel beds, so much used commercially, and the overlying Louisville beds and Devonian series have not been studied as thoroughly.

The opinion which has been frequently expressed that *all* the rock overlying the Waldron shale is Devonian and that the top of the Waldron shale marks the top of the Silurian, it is believed will not stand investigation. It seems very probable, however, in the light of our present knowledge of the subject, that it will be found that the thickness of the Louisville limestone varies considerably in different parts of the State, owing to the unconformity just mentioned, and that at many points its thickness may be inconsiderable.

A careful investigation of the boundary between the Silurian and Devonian rocks of the State might be of considerable interest to any one well prepared by great familiarity with the Devonian fauna. The fossils are rare, they are often poorly preserved, and not infrequently

shown only as casts in the debatable part of the section. But higher up fossils are often shown in sufficient perfection to make up for the deficiency elsewhere, in case the difficulties of the problem here stated should cause the interest to flag temporarily.

### III. THE LOWER SILURIAN NEAR LAUREL AS A SOURCE OF CEMENT.

The top of the Lower Silurian, near Laurel, consists chiefly of clayey layers, which often show loose fossils, or thin limestone courses, with fossils more or less irregularly distributed through them. In some places the clay elements predominate very much over the thin limestone courses. At Derbyshire Falls there is very little limestone in the section. At this point several local parties are interested in starting a cement factory, believing that the clayey materials which are here found in such abundance and with such freedom from other materials will be very suitable for the manufacture of cement. The following analyses were made by Dr. W. A. Noyes from material collected by the writer:

#### ANALYSES OF CEMENT ROCK FROM DERBYSHIRE FALLS, FRANKLIN COUNTY, INDIANA.

	I.	II.	III.
Lime (CaO) .....	27.13 %	38.11 %	24.44 %
Magnesia (MgO) .....	15.15 "	7.71 "	9.81 "
Silica (SiO <sub>2</sub> ) .....	11.57 "	9.25 "	21.51 "
Ferric oxide (Fe <sub>2</sub> O <sub>3</sub> ) .....	1.56 "	1.85 "	2.69 "
Alumina (Al <sub>2</sub> O <sub>3</sub> ) .....	4.58 "	2.95 "	8.32 "
Potash (K <sub>2</sub> O) .....	1.03 "	0.84 "	1.91 "
Soda (Na <sub>2</sub> O) .....	0.10 "	0.07 "	0.16 "
Loss by ignition (CO <sub>2</sub> and H <sub>2</sub> O) .....	38.81 "	39.03 "	31.38 "
Total .....	99.93 %	99.81 %	100.22 %
RATIONAL ANALYSES.			
Calcium carbonate (CaCO <sub>3</sub> ) .....	48.45 %	68.13 %	43.64 %
Magnesium carbonate (MgCO <sub>3</sub> ) .....	31.80 "	16.19 "	20.60 "
Silica (SiO <sub>2</sub> ) .....	11.57 "	9.25 "	21.51 "
Ferric oxide (Fe <sub>2</sub> O <sub>3</sub> ) .....	1.56 "	1.85 "	2.69 "
Alumina (Al <sub>2</sub> O <sub>3</sub> ) .....	4.58 "	2.95 "	8.32 "
Potash (K <sub>2</sub> O) .....	1.03 "	0.84 "	1.91 "
Soda (Na <sub>2</sub> O) .....	0.10 "	0.07 "	0.16 "
Combined water .....	0.84 "	0.53 "	1.39 "
Total .....	99.93 %	99.81 %	100.22 %

The analyses are based on the material dried at 135° C. The iron is partly, at least, in the ferrous state, and probably in part ferrous carbonate, but the two forms of iron were not separated.



Sample No. I. was obtained 3 feet 9 inches below the base of the Clinton, on the southern side of the quarry. It contained many worm-borings, and had a decidedly bluish appearance. It did not have a very uniform texture, and did not promise to be a very valuable layer. Its total thickness was also rather small.

Sample No. II. was obtained 10 feet below the base of the Clinton. It was a fossiliferous clayey layer. The presence of considerable lime was shown by the white color of the fossils, but the grayer color of the remainder of the rock suggested that the lime was probably not uniformly distributed.

Sample No. III. was obtained 12 feet below the base of the Clinton. It was a very even grained rock, fairly soft, and weathered back. About 2 feet of this material constituted the layer, but there was quite a considerable amount of this rock and also of rock similar to sample II. in the section.

For instance, 5 feet of rock similar to sample II., with plenty of fossils, occur just below the layer from which sample III. was derived. And just below this are 5 feet of rock similar to sample III.; the rock in this case is again worn back under the more fossiliferous layer. The pool at the bottom of the falls is 32 feet below the Clinton.

The analyses indicate that the clays at the top of the Lower Silurian can be used as a source of cement, but the cement will not have the qualities of the best cements, such as the Portland cements. The percentage of magnesium carbonate is altogether too large to furnish this quality of cement. The percentage of alkalies is also too large. But the clay will make a very fair grade of hydraulic cement, and there is such an enormous amount of material at the falls and the cement can be produced so cheaply that in the hands of experienced hydraulic cement producers the manufacture of cement at this point might become a considerable source of revenue.

#### IV. A DETAILED DESCRIPTION OF THE GEOLOGY OF THE VARIOUS LOCALITIES EXAMINED, WITH SECTIONS OF ALL THE IMPORTANT QUARRIES AND A STATEMENT OF THE USES TO WHICH THEIR STRATA ARE PUT.

It has been considered desirable to give a very detailed account of the various layers found at all the important quarries and to state the uses to which their various strata are put. The various strata in the same quarry differ so much in thickness and general value that no general description adequately reveals the possibilities of each quarry. As far as general descriptions serve any purpose the various accounts of the Laurel limestone in the earlier parts of this report have already

provided material. On the following pages will be found not only a description of the general geological conditions under which every quarry opening is found, but the character of each individual layer and the uses to which it is applied, are given as circumstantially as may be profitable in each case. Where quarries are remote from all railroad connections or have been but little operated the statements are often much less detailed. It is believed that all the more practical data are here given. Regarding the practical working of the various quarries the methods are all very primitive, excepting in the quarries already specified in the earlier part of this report which have switch connections with the railroad, and which employ steam drills, steam channelers, steam pumps and steam-operated derricks. In several cases traveling steam cranes placed on the tracks of the switches entering the quarry are employed. No other outfit was noticed at any quarry. The quarries supplied with the various conveniences just enumerated are, of course, able to lead in the competition for orders for stone, excepting in the few cases in which other quarries have natural advantages, owing to a great number of layers of stone of the particular thickness desired, or which are located at no great distance from the point to which the stone is to be shipped.

#### RIPLEY COUNTY.

##### A. OSGOOD.

104. Alfred Ashman's Quarry, Osgood.—The following section is at present exposed at this quarry:

*Laurel  
Limestone.*

- 12-18 inches of rough stone used for rubble.
- 4 inch layer, used for curb and sidewalk; this layer contains the most flint of any layer in the quarry.
- 11 inch layer, capping into a 6 and a 5 inch layer, working up into 5 and 4 inch curbs.
- 8 inch layer, with some flint, used for footings.
- 14 inch layer, with hardly any chert, capping into two 7 inch curbs.
- 10 inch layer, capping into two 5 inch layers, both containing chert, especially the lower one; both used for curbs. This is about the level of the top of the Wagner quarry south of Osgood.
- 6 inch layer, used for footings, sidewalks and rubble.
- 8 inch layer, containing a little chert; used for footings and rubble only.
- 11 inch layer, used for good curbing, after capping into a 4 and a 7 inch layer.

*Laurel  
Limestone,  
Continued.*

11 inch layer, capping into a 4 inch layer used for sidewalks, and a 7 inch layer, used for gutter stone; it is too cappy for other purposes.

5 inch layer, used for curbing and sidewalks.

9 inch layer, used for curbings, water tables and ashlar.

8 inch layer, used for curbings, water tables, ashlar.

3½ inch layer, used for sidewalks, flagging and 3 inch curbs.

9 inch layer, used for curbs, sills, water tables and all kinds of first-class dressed work.

16 inch layer, used for 12 inch water tables, and after capping into two 8 inch layers, it is used for caps of piers; it may be trimmed to 5 inch flags and curbs.

*Osgood  
Limestone.*

10 inch layer, used for curbing, all kinds of dressed work, such as water tables and also for gutter work.

Below this is the shaly clayey stone which occurs constantly a short distance below the top of the Osgood beds.

## DECATUR COUNTY.

### B. WESTPORT.

Westport Limestone Quarries.—A little over half a mile directly west of locality 194, described in the report for 1896, is the terminal of a switch, which leads from the railroad half a mile south of Westport eastward to the banks of Sand Creek. The following limestone companies are situated here: The Westport Limestone Company, Samuel A. Hollinsbe, proprietor; the Hollinsbe Stone Company, Ira J. Hollinsbe, Superintendent, and the Sand Creek Limestone Company, M. H. Sample, President, and O. H. Stout, Secretary.

The quarries nearer the creek have gone far enough into the hillside to expose the iron ledges. The section at the Westport Limestone Company is more limited, the topmost ledge now exposed being 30 inches below the level of the iron ledges. The following section was taken at this quarry:

*Laurel  
Limestone.*

About two feet of clay.

6 inch layer used for curbing and flagging.

16 inch layer capping into a 5 inch layer used for curbing and a 11 inch layer used for footings and light bridge stone.

9 inch layer used for steps, sills and caps; it is especially adapted for fine steps.

18 inch layer capping into two 9 inch layers, used for footings and bridge stone.

*Laurel  
Limestone,  
Continued.*

- 12 inch layer, very good for pier blocks.
- 7 inch layer used for flagging.
- 9 inch layer of stone used for circular curbing.
- 3 inches of chert; about a half or three-quarters of an inch of this chert hangs on to the top of the next lower layer.
- 9 inch layer capping into a 4 and a 5 inch layer used for rough sidewalks.
- 12 inch layer, with chert, used for footings.
- 9 inch layer, hard, used for flagging, footings and circular curb.
- 9 inch layer, used for scrap flag and crossings.
- 11 inch layer capping into a 4 and a 7 inch layer used chiefly for footings and bridge stone, and also for curbing and flagging.
- 5 inch layer, used for curbing and flagging, known as the smooth ledge.
- 14 inch layer, locally known as the hard ledge, capping into a 4 and a 6 inch layer, used for curbing and flagging, also two 2 inch layers, shelly and of no value.
- 6 inch layer, locally known as the flawed or fraud six, used for curbing or flagging.
- 21 inch layer, capping into a 9 and two 6 inch layers, used for flagging, curbing, sills, caps, steps and when not capped for bridge stone.
- 6 inch layer, blue, used for curbing, flagging and jail stone.

*Osgood  
Beds.*

- 14 inch layer of blue stone which withstands weathering, and after capping into two 7 inch layers is used for curbing, flagging and bridge stone. This is the stone which has proved so unsatisfactory in most of the other quarries on account of its ready disintegration.
- 14 inch layers of clay rock, locally known as the soapstone ledge; near the top of the Osgood stone.

The Osgood limestone presents the following section on the northern side of the former bed of the stream, which used to flow westward just south of this quarry; the exposure is found a short distance west of the quarry.

*Osgood  
Limestone.*

- 14 inches of densely crinoidal rock; white.
- 14 inches of clay; locally known as soapstone.
- 15 inches of limestone, containing a few crinoidal remains; forming a projecting ledge.
- 54 inches of limestone merging downward into
- 46 inches of Madison-like clay rock.
- 14 inches of quite solid light-brown rock, occupying a position very near that of the Clinton, but not resembling the Clinton in any manner.
- Below this level the Lower Silurian is well exposed.

192. A. A. McGee's Quarry.—Going from Westport a third of a mile northeastward, then a mile eastward and a quarter of a mile southward, McGee's quarry is reached. It is located at locality 192, described in the report for 1896. The section here extends some distance above the iron ledges.

*Laurel  
Limestone.*

- Several feet of clay.
- 24 inches of rough limestone.
- 16 inches of buff limestone, with chert on top.
- 8 inches of buff stone used for footings and curbing.
- 8 inches of buff stone used for footings and curbing.
- 16 inches of buff stone capping into two 8 inch layers which could be used for any purpose where heavy stone is required.
- 48 inches of coarse-grained limestone with poor bedding, locally known as the upper iron ledge, and of little value.
- 16 inches of limestone, usually not even bedded, locally known as the lower iron ledge, and of little value.
- 7 inches of stone used only for rubble.
- 17 inches of a dark-blue limestone, somewhat argillaceous, locally known as the milk trough ledge, used for monument bases, pier blocks and bridge work.
- 9 inch layer, used for curbing, flagging and corner stones.
- 12 inch layer capping into two 6 inch layers, used for curbing, flagging and window sills.
- 3 inches of shelly rock.
- 18 inches of rock capping into two 9 inch layers, used for steps, window and door sills, footings and flags.
- 23 inches of rock which may be worked together for bridge piers; or it may be capped into a 4 inch layer, used for curbing; a 7 inch layer used for curbing, a 12 inch layer used for corner stone, water tables, bridge work and steps.
- 11 inches of stone which may be worked together, or which may be quarried into a 4 and a 7 inch layer, both of which are used for curbing or flagging.
- 14 inch layer with chert, not used.
- 12 inch layer with chert, not used.
- 6 inch layer with chert, locally known as the black diamond ledge, almost worthless.
- 7 inch layer, used for curbing, flagging, 4 inch corners, sills and steps.
- 9 inch layer, with chert, used for 6 inch crossing, especially in Indianapolis and Terre Haute.
- 4 inch layer, regular, used for flag and 3 inch curb.
- 11 inch layer capping into a 5 inch layer used for curbing, crossing and flagging, and a 6 inch layer used for the same purposes.

*Laurel  
Limestone,  
Continued.*

6 inch layer, locally known as the regular 6 inch ledge, used principally for flagging, and also for curbing.  
15 inch layer capping into a 4 inch layer used for curbing, flagging, jail flag and window sills; a 5 inch layer used for similar purposes; and a 6 inch layer used for flagging and bridge backing. The last named ledge is locally known as the flawed or fraud ledge, on account of the ease with which it breaks up into irregular pieces.

21 inch layer capping into a 9 inch and two 6 inch layers, used for curbing, steps, fine bench work, fence coping and jail work.

6 inch layer, used for curbing and flagging; blue.

14 inch layer of soft stone, an inferior stone which has been used for curbing but which should not be used at all.

12 inch layer of clay rock, locally known as the soapstone ledge. This ledge is quite constantly found near the upper part of the Osgood beds.

*Osgood  
Beds.*

The underlying Osgood stone is of no value commercially, but has been worked by former quarrymen with the view of ascertaining their quality. The following thicknesses of layers were established at this time: 7, 14, 16, 6, 26 inches which would cap twice, and a 12 inch layer. Below this are 48 inches of solid rock with no sign of capping, corresponding to the Madison-like rock often found forming the lower half of the Osgood section in this part of the State.

John J. Layton's Quarry.—About three miles northward, on the western side of the creek, is the John J. Layton quarry.

The quarry has not been operated extensively for several years. A very good exposure is, however, presented by the former workings, and the following section is well exposed:

Several feet of clay.

7 feet of limestone without good bedding, used only for crushed stone for road beds; known locally as the iron ledges.

3½ inches of curbing.

11 inch layer, known locally as the milk trough ledge; used for water tables, steps, veranda blocks.

7 inch layer, capping irregularly into thin flagging.

14 inch layer capping into a 5 inch layer, used for flagging and curbing; and a 9 inch layer used for curbing, fine steps and veranda blocks.

17 inch layer capping into a 3 inch flag or curb; a 1 inch scale; a 7 inch layer used for 5 inch curbing; and 6 inches of stone used for flagging or poor gutter stone.

*Laurel  
Beds.*

*Laurel  
Beds,  
Continued.*

- 6 inch layer, used for curbing, gutter or flagging stone.
- 9 inch layer used for jail flag, jail flooring and for cells.
- 4 inch layer with chert on the bottom, used for flag.
- 9 inch layer with chert; can be used only for crushed stone for road beds.
- 4 inch layer, used for flag.
- 4 inch layer, used for flag.
- 6 inch layer, used for gutter flag and footings; it contains chert on the bottom.
- 6 inch layer with chert; can be used only for crushed stone.
- 6 inch layer, used for gutter flag.
- 5 inch layer, cherty.
- 2 inch layer, used for a poor quality of scrap flag.
- 7 inch layer capping into a 4 inch layer used for flag and not good enough for curbing; and a 3 inch layer used for similar purposes.
- 13 inch layer capping into a 4 inch layer used for flag and curbing; a 6 inch layer used for gutter stone and flag, not good for curbing; and 3 inches used for flagging, and a good quality of curbing.
- 5 inch layer, locally known as the regular ledge, used for flagging and curbing.
- 9 inch layer, forming the hard ledge, capping into a 5 and a 4 inch layer, used for flagging and curbing.
- 4 inch layer, used for flagging, poor quality, owing to readily breaking up in an irregular manner.
- 6 inch layer, locally known as the flawed ledge; as the name implies, the stone is of inferior value, breaking up irregularly.
- 21 inch layer, capping into a 4 inch layer, under which is a second 4 inch layer, both used for flagging and curbing; and two 6 inch layers used for gutter flag. This is the lowest layer which will stand weathering.
- 6 inch layer, good for 4 inch curbing.

*Upper Part  
of the  
Osgood Beds*

- 14 inch layer capping into two 7 inch layers of blue stone of very inferior quality, notwithstanding the influences of weathering.
- 16 inch layer of clayey rock, known locally as the soapstone ledge; this is the blue clayey layer which so readily disintegrates into a clay bed, where long exposed to the influences of weathering. It belongs to the upper part of the Osgood beds, the 14 inch layer overlying the same being also a part of the Osgood beds, although not to be distinguished from the overlying Laurel beds so far north of the typical Osgood beds.

## C. HARRIS CITY.

Harris City Quarry.—The following section is exposed in the extensive quarries located in this area:

*Laurel  
Limestone.*

Several feet of clay.

6 feet of hard limestone with poor planes of separation along the bedding, locally known as the iron ledges.

18 inch layer, used for bridge blocks and bases.

5 inch layer, used for flagging.

16 inch layer, locally known as the milk trough, used for bases, piers and general bridge work.

9 inch layer, used for flagging.

18 inch layer, used for bridge bases.

17 inch layer, used for bridge work and pier blocks; after capping into 10 and 7 inch layers it is used for range work and water tables.

12 inch layer, used for coping, pier blocks and pier caps.

9 inch layer, used for range work and good solid water tables.

8 inch layer, used for curbing after capping into two 4 inch layers.

7 inch layer, used for good solid curbing and flagging.

13 inch layer, used for bridge work; after capping into 7 and 6 inch layers, it is used for gutter and curb stones; a few white spots of chert are present.

5 inch layer, used for curb or flag.

32 inch layer of a cheap grade of stone, with chert, used chiefly for footings; it caps into 8, 12 and 10 inch layers.

11 inch layer; this is the top of the very best stone; after capping, the 4 inch layer is used for very good curbing, and the 7 inch layer for flagging and crossing, but this layer is not good for curbing.

6 inch layer, used for curbing and flagging; a good solid layer.

4 inch layer, used for 4 inch curbing; solid.

7 inch layer, used for curbing and flagging; it has two thin shells on the bottom.

5 inch layer, used for flagging, sidewalks, jail flooring and ceiling, curbing and crossing.

21 inch layer capping into a 1½ inch shell; a 9½ inch layer used for water tables, range work and pier caps; a 6 inch layer used for curbing and flagging; and a 5 inch layer, used for flagging.

1 inch shell.

6 inch layer, used for flagging, jail flooring and cellar flagging; too soft for sidewalks.



<i>Osgood Beds.</i>	14 inch layer capping near the middle, used for curbing, gutter stone, jail flag; too soft for outside work.
	14 inch layer, locally known as soapstone.

The Clinton is exposed at Parker's Mill (188), about a mile south of Harris City. A short distance south of Harris City a road turns off from the pike and crosses the creek eastward. Just below the bridge the base of the Osgood beds is exposed in the bed of the stream. It is a brown stone layer about 1 foot thick. The lower overlying Osgood beds are not exposed, but about  $4\frac{1}{2}$  feet higher about 3 feet of poor limestone, with clayey courses, such as are characteristic of the Upped Osgood beds in this part of the country, are shown. Seven feet and six inches above the brown limestone exposed in the creek bed a blue clay layer, 1 foot thick, is exposed. This layer and the overlying layer of limestone may be traced northward along the creek to a short distance below the quarry. This blue clay and possibly the overlying layer of limestone are to be included in the Osgood bed, but if this be the case this limestone bed can not be distinguished lithologically or paleontologically from the overlying Laurel beds.

As far as may be judged from conversation with the quarrymen the upper shale or clay is known to them as the soapstone ledge, and seems to be harder where reached in their quarrying operations. It is said by them to be 16 inches thick. The overlying limestone layer is 14 inches thick, and is considered a good quarry stone.

According to barometrical measurements the level of the Clinton, at Parker's Mill is 155 feet below Greensburg, or 800 feet above sea level.

#### D. NEW POINT, ST. MAURICE AND NORTHWARD.

201. New Point Quarries.—A mile north of New Point, east of the road, along a branch of Salt Creek, and a quarter of a mile west of Rossville, are the Big Four quarries. The following section is here exposed:

*Laurel  
Limestone.*

- 5 to 10 feet of clay.
- 1 to 3 feet of rip-rap, with chert.
- 3 inch layer, used for well-stone and light rubble.
- 12 inch layer, capping into 4, 4 and 3 inch layers, used for curbing and footings.
- 8 inch layer, used for footings, walk-stone, gutter-flag and street-crossings; near the middle this layer contains chert nodules.
- 8 inch layer, with the same uses as the preceding, but consisting of a somewhat better quality of stone.

*Laurel  
Limestone,  
Continued.*

- 8 inch layer, with the same uses as the two preceding.
- 15 inch layer, capping into an eight and a 6 inch layer.  
This layer is roughly seamed near the middle, and contains some white chert.
- 7 inch layer, used for footings.
- 6 inch layer, used for fine dressed work, window sills, etc.
- 8 to 10 inch layer, used for footings and dressed work.
- 4 inch layer, used for flagging, curbing and ashlar.
- 4 inch layer full of chert, used for rubble. Sometimes the two 4 inch layers hang together, and contain less chert; they are then used for footings, curbs, culvert crossings and pier blocks.
- 10 inch layer, known locally as the regular layer; it contains chert and is used for footings.
- 2½ inch layer, used for thin scrap and sidewalks.
- 9 inch layer, used for all kinds of dressed work, from street to building purposes. It caps into a 6 and a 3 inch layer; the stone is then used for copings, sidewalks and curbings.

*Osgood  
Beds.*

- 16 inch layer, used for heavy coping, pier blocks and other bridge work. It caps into a 9 and a 7 inch layer, and is then used for steps, curbing, door sills and water tables. The stone is streaked horizontally with more argillaceous layers.
- 20 inch layer of clay, or shaly clay, locally known as soap-stone.
- 12 inch layer, often with 4 inches of clayey stone on top and with the lower 8 inches rough, and used only for rip-rap and foundations.
- 24 inch layer, used for bridge work, chiefly for bridge backing and other interior work. Argillaceous and limestone courses are combined in a sort of streaked fashion.
- 12 inch layer, used only for footings.
- 40 inch layer, used for bridge work; consisting of clay and limestone in streaks; sometimes the lower 10 inches may be capped off, and form a fairly good stone for footings and bridge copings.
- 6 to 8 inch layer, with about 5 inches of good stone, used for rubble, footings and curbing.
- 33 inches of Clinton rock.

The level of the top of the Clinton lies about 25 feet below the railroad at New Point.

203. St. Maurice.—About 3 miles north of Rossville is St. Maurice. Nearly a mile southward one of the branches of Salt Creek exposes the Clinton. At least 4 feet of salmon-brown rock are exposed, but this is probably not the total thickness. The Osgood beds are exposed in the branch a short distance eastward.

204. About half a mile east of St. Maurice the Clinton is better exposed in another branch of the same stream. It is here  $5\frac{1}{2}$  to 6 feet thick; it has a salmon brown color, contains white lenses of a finer grained limestone, the latter often occurring as irregular layers or patches of small extent. Below the Clinton are 8 inches of white clayey, nodular limestone, containing, near the top, salmon-colored crinoidal fragments.

The top of the Lower Silurian limestone ledge just beneath shows good strong wave marks, with a trend of north,  $15^{\circ}$  east.

205. Larkin Walter's Quarry.—About two miles east of St. Maurice and about two miles north of this line, the line between Decatur and Franklin counties crosses another branch of Salt Creek. Between 5 and 6 feet of salmon brown Clinton are exposed a short distance south of the road crossing. The Osgood beds are seen in the banks of the stream. The Laurel formation is seen at Larkin Walter's quarry, a short distance northward. The stone is used for local purposes.

#### E. SANDUSKY AND FLAT ROCK EXPOSURES.

Sandusky.—About a quarter of a mile east of Sandusky the road crosses the southern branch of Clifty Creek. Several hundred yards up the creek is located a quarry, known as Meek's quarry. The Waldron is here well exposed and contains numerous species belonging to the characteristic Waldron fauna. The upper 2 feet of the Waldron shale contain few fossils. Below these lie 3 feet of clay, with thin, intercalated limestone layers, both the clay and the limestone containing numerous fossils. Under these lie  $2\frac{1}{2}$  feet of poor clayey rock, which contain no fossils, but form a lithological gradation between the Waldron shale and the Laurel beds below. The stone from this level down to the chert beds is a very good quality of limestone for this part of the country, and is the stone sought in this quarry.

Overlying the Waldron shale is a stone which seems to be a very sandy limestone. The same layer is found in the bottom of Sand Creek, about half a mile east of Greensburg.

Between Meek's quarry and the bridge east of Sandusky is located a deep hole in the stream bed, which is known as Douglas Hole. At this point the horizon of the Waldron shale is variously occupied by thin clay layers; by clay with frequent thin intercalated limestone layers, full of fossils; and occasionally by solid white limestone masses which contain the fossils in a matrix formed by the very fine grained material, of which the limestone is composed. These limestone

masses are always very irregular in form, sometimes coarse lenticular masses, and the color is often light blue, rather than white. Masses of this kind are also found in the regular Waldron shale at the famous fossil locality on Conn's Creek, south of Waldron. They show a manifestation on the part of the shale to become more of a limestone formation on going northward in the State; for the Waldron shale in the southern part of Indiana does not contain this limestone, even in the form of irregular masses, while at Sandusky and at various localities on Conn's Creek and Flat Rock Creek the limestone masses just described are not uncommon. In some of the more northern counties of the State the horizon of the Waldron shale is quite well marked, but it is here represented only by a series of very fossiliferous limestone layers, which contain the very characteristic Waldron fauna.

At Douglas Hole the limestone below the Waldron horizon is very crinoidal. The upper layers of this stone contain numerous Waldron fossils. The total thickness down to the level of cherty beds is about 6 feet. There is a considerable thickness of cherty limestone.

The measurements at the bridge east of Sandusky for this same section are very different. Here at least 13 feet of limestone, free from chert, are exposed beneath the level of the Waldron shale before the first chert layer is reached. This layer is about 4 inches thick. Beneath this are 9 inches of limestone, the lowest layer exposed at this point. Near the middle of this section were obtained *Pisocrinis gemiformis* and a pygidium of some species of *Illænus*. It is evident that some of the layers which contain chert at Meek's quarry, Douglas Hole, and at the bridge north of Sandusky are free from chert at the bridge east of Sandusky. This failure of the chert to appear at the same levels in closely contiguous localities is very instructive in relation with the problem as to the origin of the chert beds in the Laurel formation in Indiana.

East of the railroad bridge north of Sandusky the Waldron shale is again very well exposed. It is here 4 or 5 feet thick, and is overlaid by a sandstone or sandy limestone layer about 1 foot thick. Below the Waldron shale there are about 6 feet of crinoidal limestone. Underlying this are 4 inches of chert, 1 foot of limestone, and then 8 feet of cherty limestone. This section corresponds very nearly with the section at Douglas Hole. The cherty limestone is best exposed west of the bridge crossed by the pike, north of Sandusky. The top of the Waldron shale lies 6 feet below the level of the railroad bridge.

Flat Rock Creek Exposures.—In section 4, Adams Township, about 3 miles west of Sandusky, about 15 feet of very cherty limestone are exposed on the north side of the creek and form a vertical bank. It is

correlated approximately with the cherty layers near Sandusky. A quarter of a mile southward from the last locality is found the Sandusky-Downeyville Pike.

One mile west of the last locality, on the north side of the stream, near a stone bridge, about 12 feet of stone of fair quality have been quarried for the abutments of the bridge. It contains but little chert. Nevertheless the geological horizon of this stone should differ but little from that of the cherty beds at the locality last described.

Downeyville.—Along the creek south of Downeyville the 5 feet of stone above the creek bed are of inferior quality. At their top is a thin layer, containing *Pisocrinus gemmiformis* and *Atrypa reticularis*. The  $4\frac{1}{2}$  feet of limestone overlying this bed form the building stone of this region, but the stone is bluish and much inferior to the fine stone at the Lemon quarry on Big Flat Creek, to which it is equivalent. Overlying this are 2 feet of stone with occasional chert layers and nodules, and, therefore, of inferior quality. Above this are 4 feet of white limestone, which in this locality do not seem to be of value.

Jarett R. Lemon Quarry.—This quarry is located a mile north of Downeyville, on Big Flat Rock Creek, south of the creek and east of the road. As at the last locality, the good quarry stone is found beneath the cherty beds, and the overlying beds are of inferior quality. The good quarry stone is  $5\frac{1}{2}$  feet thick, the overlying cherty beds are 2 feet thick, and the upper inferior limestone is  $11\frac{1}{2}$  feet thick; total, over 19 feet. The beds belong near the middle part of the Laurel limestone. The following descending section will give a better notion of the commercial value of the rocks exposed in the quarry:

Laurel  
Limestone.

- |   |   |  |
|---|---|--|
| <p>4 feet of water worn and weathered stone, irregularly<br/>seamed and evidently of inferior value.</p> <p>10 inch layer.</p> <p>3 inch layer.</p> <p>5 inch layer.</p> <p>8 inch layer.</p> <p>2 inch layer.</p> <p>4 inch layer.</p> <p>3 inch layer.</p> <p>3 inch layer.</p> <p>9 inch layer.</p> <p><math>3\frac{1}{2}</math> inch layer.</p> <p><math>3\frac{1}{2}</math> inch layer.</p> <p>4 inch layer.</p> <p>11 inch layer.</p> <p>8 inch layer.</p> <p>13 inch layer, would probably split up.</p> <p>3 inch layer of irregular stone.</p> | } | <p>Stone only<br/>fairly good,<br/>and there-<br/>fore not<br/>quarried to<br/>any great<br/>extent.</p> |
|---|---|--|

<i>Laurel Limestone, Continued.</i>	}	6 inch layer with chert nodules along the middle and a thin chert layer at the top.	} Cherty beds.
		8 inch layer which would probably split.	
		5 inch layer with a thin chert layer at the top.	
		4 inch layer.	
		11 inch layer, apparently splitting irregularly, its upper surface covered with cherty nodules.	
	}	6 inch layer of rather fair stone.	} Very good building rock.
		6 inch layer.	
		5 inch layer.	
		6 inch layer.	
		4 inch layer.	
		4 inch layer.	
		5 inch layer.	
		6 inch layer.	
		4 inch layer, of little value.	
		8 inch layer.	
		Creek bed.	

## F. ST. PAUL.

H. C. Adams' Quarries.—Two quarries are being worked; one is located a short distance north of the railroad bridge on the eastern side of the creek, and the other is located about a mile farther north on the western side of the creek. A private switch connects the two quarries and the Scanlan quarries to the south with the railroad. The following section was taken chiefly from the more southern quarry, north of the railroad, the lower part of the section being completed from data obtained at the more northern quarry, which has been worked longer and deeper.

<i>Laurel Limestone</i>	}	7 feet of limestone, full of chert.	
		9 2-3 feet of bluish limestone, not divided into good layers but working out rough. Not quarried.	
		16 inch layer; a rough ledge used for rip-rap.	
		18 inch layer, used for fine work and coping.	
		14 inch layer, capping into an upper 8 and a 6 inch layer, both used for flagging.	
		10 inch layer; good.	
		24 inch layer used for first-class work; when capped into 6, 8 and 6 inch ledges with a useless shell on top the thinner layers are used for curbing.	
		12 to 16 inch layer, used for coping and fine dressed work.	

*Laurel  
Limestone,  
Continued.*

- 16 inch layer, used for coping, fine dressed work and water tables. This ledge contains cherty nodules which are, however, not very hard.
- 12 inch layer, used for footings for heavy buildings and light bridge work.
- 12 inch layer, used for the same purposes as the last.
- 18 inch layer, capping into three 6 inch layers used for flagging. Base of the southern quarry.
- 40 inch layer, capping into the following layers in descending order: 9-10 inch used for curbing, sidewalks and coping; 4 inch curbing and flagging; 12 inch water table and coping; 4 inch layer used for bridge backing, curbing and flagging; 8 inch layer used for sidewalks, curbing and coping.
- 8 inch layer, used for curbing, sidewalks and coping. This is the lowest layer now being worked in the more southern quarry; the following layers are shown in the quarry a mile north, up the creek.
- 21 inch layer used for bridge purposes.
- 21 inch layer used for bridge purposes. This is the lowest of the layers of limestone which are of best quality.

*Osgood  
Beds.*

- 12 inch layer used for footings.
- 36 inch layer capping into 18 inch layers used for bridge pier blocks. This is called the upper brown ledge, although its color is not brown in this quarry.
- 12 inch layer, used for footings; called the lower brown ledge. The last two layers are of inferior quality.
- 2 feet of blue clay and shale, locally known as soapstone.

The soapstone and brown ledges are believed to be the equivalent of the Osgood beds of more southeastern localities, the overlying 12-inch layer may possibly be also included. The blue clay and shale is said to be richly fossiliferous, but at the time of my visit it showed only *Platystrophia bifurcata*. The overlying 12-inch layer is an argillaceous limestone, and in the Scanlan quarry, where it was first exposed, showed a strong brownish color; in the Adams quarry its color is more bluish. The 36-inch layer has a bluish or greenish blue color; the rock is not even grained, but consists of irregular courses of fine-grained bluish argillaceous rock, alternating with more calcareous and whiter material; the latter occurring sometimes in the form of streamers or lenses in the more argillaceous rock. This structure is characteristic of the Osgood beds in their more northwestern exposures, and, therefore, these beds have been correlated with the Osgood layers elsewhere.

J. L. Scanlan's Quarries.—A quarter of a mile south of the railroad crossing, on the southeastern side of Flat Rock Creek, are several quarries, worked by J. L. Scanlan. The combined section shown by three quarries is as follows:

*Waldron  
Shale.*

{ 6 feet of clay.

{ 8½ inch layer.  
4½ inch layer.  
3 inch layer.  
5 inch layer.  
4½ inch layer.

} Softer limestone, blue, somewhat  
magnesian.

{ 10 inch layer.  
8 inch layer.  
5 inch layer.  
6 inch layer.  
6 inch layer.  
5 inch layer.  
6 inch layer.  
7 inch layer.  
7 inch layer.

} Very good stone for building purposes.

2 feet of white limestone; poor.

6 1-3 feet of limestone with frequent chert layers, excellent as rubble for road purposes. Base of upper quarry.

15 feet of limestone not good for building purposes because not coming out in good layers, but quarried for rubble for roadbeds, and formerly used for making lime.

*Laurel  
Limestone.*

{ 11 inch layer.  
4½ inch layer.

12 inch layer with chert nodules.

12 inch layer. The stone from the base of the chert beds down to this level is exposed above the middle quarry, but is at present not worked.

8 inch layer, the top of the portion of the middle quarry now worked.

24 inch layer.

8 inch layer.

8 inch layer.

10 inch layer.

9 inch layer.

12 inch layer.

48 inches of limestone which split up into layers varying from 4 to 8 inches in thickness.

24 inch layer, solid. Base of middle quarry.

24 inch layer capping into 12 inch layers, at present being entered at the middle quarry.

Excellent  
building  
stone.



Osgood  
Beds.

- 14 inch layer capping into 7 inch layers, exposed in the lower quarry only. It is said to be a white limestone and is the base of the fine building rock.
- 30 inch bed capping into a 12 and a lower 18 inch layer. The stone is said to be brownish, and to resemble the underlying layer. It was formerly worked in the lower quarry.
- 14 inch layer, argillaceous limestone, of brown color where weathered.
- 3 feet of blue shale, locally called soapstone.

The Osgood beds were formerly worked in the lower quarry. The best building stone is near the base of the Laurel bed. The next best stone is from the upper part of the Laurel bed. The middle part of the Laurel bed is spoiled by the presence of considerable chert. The Osgood bed consists of of an inferior quality of stone.

Towards the railroad the Waldron shale is overlaid by  $3\frac{1}{2}$  feet of limestone, weathering brownish, and containing *Cladopora*, *Syringopora* and *Favosites*. While the species could not be identified with certainty, Mr. G. K. Greene thought they had a Niagara facies, and the limestone is therefore considered part of the Louisville bed. The base of the Waldron shale is about 831 feet above sea level.

## SHELBY COUNTY.

## G. WALDRON TO GENEVA.

William Avery's Quarry, Waldron.—A mile and a quarter south of Waldron, on Conn's Creek, is the famous locality from which Prof. Hall secured the many fossils which have made the Waldron horizon so famous. The diggings were made on the western side of the creek, but so much time has elapsed since the last collectors have attempted to exploit this place that the fossil-bearing part of the shale is no longer well exposed. Directly east of the fossil locality is the quarry. The Waldron shale forms the base of the quarry. The shale and the overlying limestone slope towards the northwest at the rate of  $7\frac{1}{2}$  feet in one hundred. The limestone is conformable to the Waldron shale below; in the northern part of the quarry a section of 8 feet was measured. In the northwestern part of the quarry its thickness must once have been greater, but at present its surface in that direction does not admit of measurement. In the southeastern part of the quarry its thickness is considerably less than 8 feet, owing to the fact that the upper surface of the limestone was considerably eroded before the deposition of the next overlying beds.

The erosion of the upper surface of the limestone and the tilting of the beds have been of such a character that notwithstanding the evident unconformity the beds above the unconformity have at present a practically horizontal position, while the underlying beds are tilted towards the northwest. The limestone below the unconformity is quarried as a very fair quality of building stone, the lower beds making good curbing, flagging and coping, and consisting of light brown limestone, while the upper beds are of a darker drab or blue color and do not quarry out in nice slabs, forming only an inferior quality of stone. The stone overlying the unconformity is apparently a very argillaceous limestone; it resembles a fine-grained sandstone in texture, and has a brown color, due to weathering.

There seems to be no reason for excluding the limestone overlying the Waldron shale from the Niagara group; fossils have been found in similar positions at St. Paul, which are certainly of Niagara age. But the geological position of the limestone overlying the unconformity is much less evident. I shall call it for the present the Shelby bed. It may possibly represent in this region the base of the Devonian. At any rate the unconformity may be traced for several miles down the creek and the overlying argillaceous limestone may be recognized in the neighborhood of Hartsville, in Bartholomew County.

The following section was taken in the northeastern part of the quarry, where the best stone is obtained at present:

<i>Lower Devonian.</i>	{ 2 feet of argillaceous limestone having the appearance of a fine-grained sandstone.	
<i>Louisville Bed.</i>	{ 2 feet of brown limestone of no value.	
	{ 8 inch layer capping into 3 and 5 inch layers.	
	{ 6 inch layer.	
	{ 10 inch layer capping into 2 and 8 inch layers.	Stone of moderate value, not coming out in good slabs.
	{ 4 inch layer.	
	{ 10 inch layer capping into two 5 inch layers.	
	{ 7 inch layer.	
	{ 2½ inch layer.	
	{ 8 inch layer.	
	{ 8 inch layer.	
	{ 5 inch layer.	
	{ 12 inch layer capping into two 6 inch layers.	A good quality of stone especially for curbing and flagging.
	{ 7 inch layer.	
	{ 5 inch layer.	
	{ 4 inch layer.	

*Waldron* {  
*Shale.* { 6-8 feet of shale.

George Wright Locality.—About 2 miles southwest of the William Avery quarry and three-fourths of a mile below the junction of Conn's Creek with Flat Rock Creek, is the house of George Wright. A road comes down to the creek just south of this house and the Waldron shale exposed along the eastern side of the creek just north of the road is very fossiliferous. The overlying limestone has weathered into a brown rock.

Mary Wurtz Locality.—About one mile down the stream from the George Wright locality and  $1\frac{1}{4}$  miles above Geneva, is the former Mary Wurtz farm. Along the western bank of the creek the Waldron shale is poorly exposed. This used to be a very fine fossil locality, but at present only serves to show the presence of the shale. The limestone above the Waldron shale and correlated with the Louisville bed is here only  $5\frac{1}{2}$  feet thick, and was formerly quarried. The Shelby bed overlying the same may be seen to be unconformable to the limestone below, after having studied the locality at Avery's quarry. It here contains traces of fossils, but these are in the form of exterior casts left by the leaching away of the lime of the fossils themselves, and are very poor.

Geneva.—A short distance above the bridge, on the west side of Flat Rock, near Geneva, is the Gregory lime quarry. About 31 feet of limestone are exposed above the level of the massive brown limestone which forms the lower part of the Shelby bed. It is a strongly dolomitic stone and has a brownish or bluish color in the different courses. Its bedding is irregular, and it is not suitable for a building stone, excepting for neighborhood purposes. It is said to burn into a very good quality of lime, and was operated for this purpose at the time the quarry was examined. The more massive dark brown rock, which evidently forms the base of the Shelby bed, is well exposed a short distance farther up the creek. It apparently reaches the creek level near the quarry.

#### RUSH COUNTY.

##### H. MILROY.

Milroy.—At the bridge directly west of Milroy the Waldron shale is only 1 foot 6 inches thick. It is overlaid by  $5\frac{1}{2}$  feet of poor agrillaceous limestone. At Ben Rardin's quarry, about half a mile south of Milroy, the Waldron shale thins out to about 6 inches near the southern end of the quarry. About  $7\frac{1}{2}$  feet of limestone are exposed

beneath this level, only the lower part of this containing chert. While most of this stone is of considerable value locally for cellar stone, flagging and curbing, it is at present but little employed except for crushed stone for roads.

## JENNINGS COUNTY.

### I. VERNON.

Tunnel Mill, Vernon.—The Upper Devonian rocks are very well shown by the exposures along the road leading from the Tunnel Mill eastward towards Vernon. The black shale forms the top of a hill, over which the road passes. The middle part of the section is seen on going down the hill, eastward and westward. The lower part is exposed along the northern side of the creek, near the southwestern outskirts of the town. All of these sections have been combined in the following continuous section:

<i>Black Shale.</i>	{	About 25 feet exposed; the total section of shale not exposed.
<i>Crinoidal, and Brachiopodal Limestone.</i>	{	4 inch layer; fine-grained impure limestone, blue.
	{	30 inch bed of crinoidal limestone; fossils.
	{	18 inch layer of dark-blue limestone, without fossils; represented east of the hill summit by shaly dark limestone.
	{	10 inch layer of limestone containing black nodular masses, and numerous fish teeth; also the brachiopods found in the next lower layer.
	{	54 inches of crinoidal limestone with many brachiopods. West of the hill summit this bed contains several thin chert layers with well preserved fossils.
<i>Banded Limestone.</i>	{	96 inches of closely banded limestone; correlated with the cement rock in southern Indiana.
<i>Coral Beds.</i>	{	96 inches of limestone containing corals at various levels; these are in the form of much rounded fragments near southwestern Vernon, but consist of better preserved remains in the section east of the Tunnel mill. The lower third of this limestone is often weathered so as to leave cavernous openings.
	{	6 inch layer of closely banded limestone; usually without fossils.
	{	108 inches of limestone with coral remains, the corals being best preserved in the Tunnel mill section.

- Lower Devonian.* { 148 inches of massive rock, the lower 4 feet of which often are softer, showing a peculiar vertical system of fracture which causes the lower part of this rock to scale off and allow the upper part to project. This lower rock is blue in color.
- Of Uncertain Age.* { 58 inches of limestone; the upper 3 feet consist of hard rock forming a projecting ledge; an 8 inch layer lies beneath, and the 14 inch layer below the last contains worm borings. The lower layers are composed of blue argillaceous limestone.
- Waldron Shale.* { 66 inches of thin, blue, clayey shale, containing fossils.  
14 inches of bluish, hard argillaceous rock.
- Laurel Limestone.* { About 10 feet of Laurel limestone are exposed here, the total section not being seen.

North Vernon.—The following very instructive section of Devonian rocks is exposed along the road leading from North Vernon north-eastward to the waterworks pumping station:

- Black Shale.* { Total section not exposed.
- Crinoidal and Brachiopodal Limestone.* { 48 inches of blue, shaly limestone with brachiopods, bryozoans, and a few corals. This bed is represented by crinoidal limestone on going a short distance eastward along the quarried face of the hill.  
15 inch layer of crinoidal limestone with numerous fish teeth well shown south of the pumping station.  
44 inches of buff limestone, full of brachiopods. North of the pumping station on the other side of the road it contains large irregular masses of chert.  
There is evidence of erosion in the underlying beds previous to the deposition of the last described bed.
- Banded Limestone.* { 55 inches of closely banded limestone, with shaly partings; dividing into 12, 11, 26 and 6 inch layers.  
72 inches of buff and blue limestone, inclined to be massive, but often giving evidence of close banding. Small irregular cracks filled with calcite often traverse the rock. This is part of the once famous North Vernon limestone.  
42 inches of closely banded limestone. This is probably equivalent to that part of the coral section as described from Vernon, which lies above the banded limestone, there seen a little above the middle of the coral beds.
- Coral Beds.* { 48 to 60 inches of limestone with frequent coral remains.
- Lower Devonian.* { 120 inches of massive buff limestone.  
54 inches of dark-brown limestone, with rare traces of corals.

- Of Uncertain Age.* { 93 inches of dark-brown massive limestone; the color is due to the weathering of stone containing iron.
- Waldron Shale?* { 48 inches or more of argillaceous limestone which possibly may represent the Waldron shale, but whose precise geological position can be determined only after more detailed study than it is possible to give at present.

## BARTHOLOMEW COUNTY.

## J. LITTLE SAND CREEK AND NEWBERN.

Manley's and Case's Quarries.—Going from Newbern southward 1 mile, then a little over 2 miles westward and 4 miles southward, the road crosses Little Sand Creek. On the south side of the creek is the quarry of James Manley, worked chiefly for lime. Here the following section is exposed:

- Black Shale.* { A few feet; the total thickness of the shale is not seen.
- Crinoidal and Brachiopodal Limestone.* { 2 feet of blue limestone with many fossils.  
2 feet of limestone with chert nodules. Small black nodular masses and numerous fish teeth occur about one-third of the way down in the layer.  
4 1-3 feet of grey limestone with some brachiopod remains. Cherty nodules occur at the base.  
1¾ feet of grey limestone, often weathering brown.
- Banded Limestone.* { 10 feet of closely banded, fine-grained grey limestone lie beneath the layers previously described; no fossils were found in them; these layers are used for lime in the Case quarry. The upper surface of the banded rock is usually wavy.

John Yeaty Locality.—A mile north of Newbern, a mile and a half west, and then about a quarter of a mile northward again, a house is reached, a short distance beyond which a road leads off towards the east, through the fields to John Yeaty's farm house. A short distance north of the house a little dry run enters the creek valley from the east. In it the black shale is well exposed. Just beneath the shale a layer of crinoidal limestone about a foot thick is seen. Beneath this about 4 feet of limestone, with frequent brachiopod remains, is found. All of the section below the black shale belongs to the same portion of the Devonian as that included in the Vernon sections under the crinoidal-brachiopod limestone.

Newbern.—Newbern is about 4 miles down the creek from Hartsville. A short distance west of town, on the north side of a residence facing the creek, a small exposure of chert is found, forming a layer not more than 2 feet thick. The chert is here fossiliferous, but most of the corals which constitute the fossil portion of this bed can not be readily recognized. A short distance east of this locality and east of the road leading from the bridge into town a little gray limestone is seen exposed along the roadside. Several good specimens of *Conocardium trigonale* were found here.

The chert layer, with its overlying *Conocardium* limestone, undoubtedly belongs to the same horizon as the chert and *Conocardium* beds at Hiner's branch, northeast of Hartsville. The chert is the attenuated northern equivalent for the much better developed coral beds of Vernon and southwards. The *Conocardium* limestone is probably the basal portion of the banded limestone, though the presence of corals above the *Conocardium* bed at Hiner's branch should be noted. It will, of course, require close paleontological study to determine these questions.

#### K. HARTSVILLE AND VICINITY.

Hiner's Branch.—About a mile north of Hartsville, Hiner's Branch enters the creek from the east. The level of the Waldron is just above the limestone underlying the roadbed for a long distance east of the creek. About 30 feet above the level of the Waldron shale is found a quartziferous or cherty layer, which is first well exposed about an eighth of a mile up the branch, on the north side of the stream. The quartziferous layer contains fossils. They are not well preserved, but were recognized. The limestone immediately beneath also contains a few fossils, but their geological position can not be so readily determined, since they consist mostly of corals, which are not very distinctive. While the cherty layer can be traced for long distances up the branch, especially on the north side, it frequently runs out, and its horizon can then be followed only by means of the cavernous nature of the limestone bed, of which it usually forms the upper part. Following the cherty layer up the creek from its first exposure on the land of John Galloway, half a mile northward, to the end of the woodland on J. C. Graham's farm, the corresponding stratum is found to be overlaid by 5 feet 6 inches of whitish limestone, the upper part of which contains *Conocardium trigonale*. This fossil is especially abundant south of the stream, near the east end of the woods, the fossiliferous layers being well exposed on the fairly level

surface of the woods, although the area of exposure is small. In a little run east of the fence, near the west end of the woods containing the last named exposure, a foot of limestone overlies the *Conocardium* layer; it contains a considerable number of corals. Above it lie 3 feet 8 inches of a very fine-grained white limestone, with abundant close bedding, very much resembling the finer grained rock at the base of Case's quarry.

As already stated, the cherty or quartziferous layer probably represents in a measure the coral bed of more southern localities, while the *Conocardium* bed belongs to the upper part of the coral bed, or still more probably, to the lower part of the banded limestone. The occurrence of the banded limestone still farther up in the section is of interest in this connection.

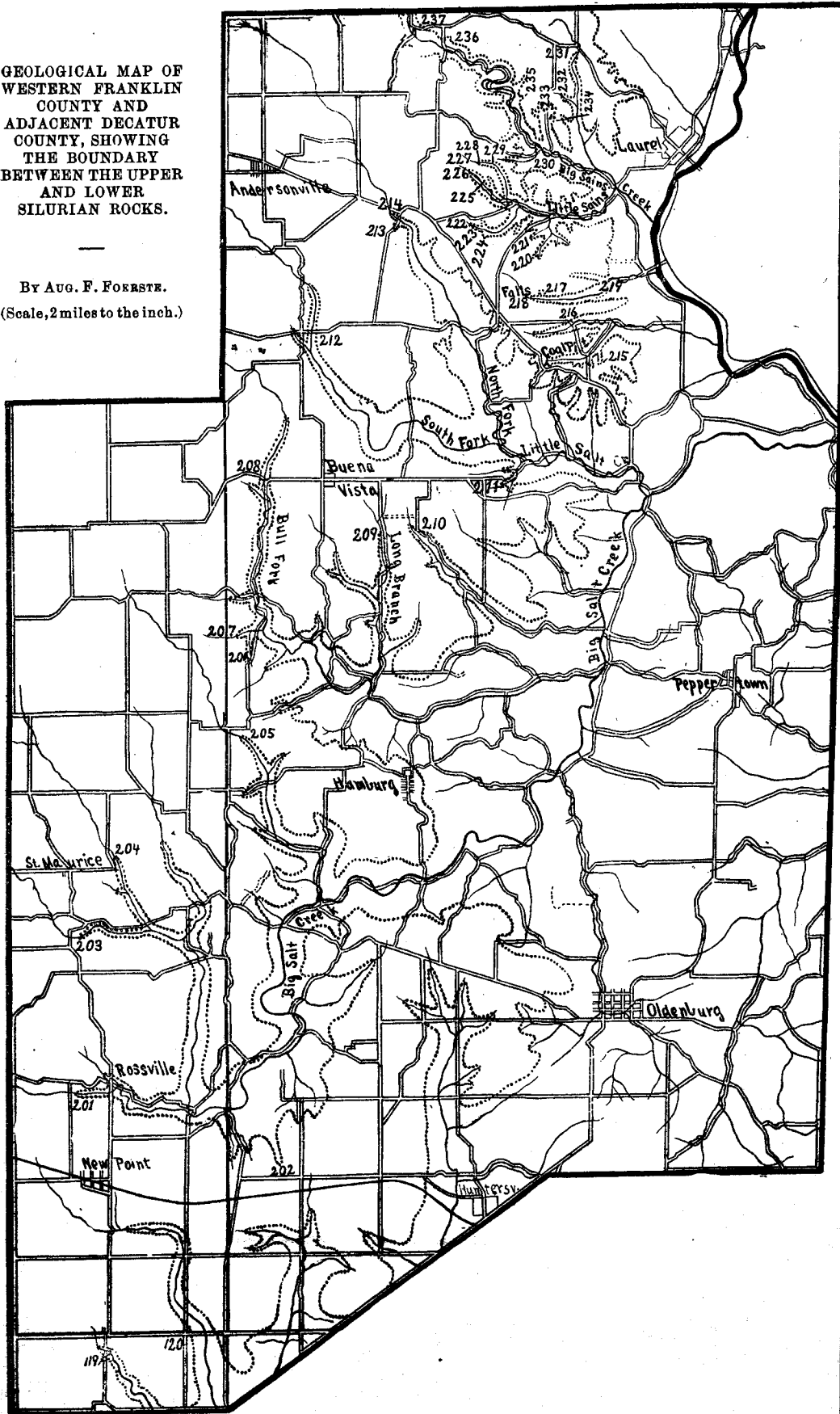
Long's Falls.—The Waldron shale may be readily followed along Clifty Creek, from Hartsville southward to the Tarr Hole, half way between Hartsville and Newbern. Some of the best fossil localities now accessible in this shale occur in this region. One good fossil locality is on the west side of the creek, a mile south of Hartsville, on the farm belonging to Francis A. Crump. A little stone is being quarried on the north side of a small branch near its junction with the creek, and a short distance farther up the branch the Waldron shale contains many fossils. Another locality is found a quarter of a mile southward, along the northern and eastern margins of the cornfield northeast of the bridge which crosses the lower end of Middle Fork, near its junction with Clifty Creek. A quarter of a mile southwest of this bridge, at Tarr Hole, is another good locality. The Waldron shale is exposed along the branch entering Clifty Creek at the bridge, up stream as far as two falls, situated upon two forks of the branch. The more northern of these is Long Falls, on Middle Fork. Just below the falls the upper part of the Laurel limestone is quarried to a moderate extent for building purposes. At the falls the Waldron shale forms the lower vertical part of the fall. The overlying rock forming the upper part of the fall and the bed of the stream above the fall is a poor limestone of light-brown color, containing no fossils in the lower five feet of its exposure, but with a fair number of corals in a layer just above this level. While these fossils are not well preserved, Mr. G. K. Greene was able to recognize in the material submitted to his examination *Favosites limitaris* and *Cladopora cryptodens*. Of course this indicates that the rock within five feet of the Waldron shale is Devonian at this locality. The five feet of rock above the Waldron shale remain of uncertain age.



GEOLOGICAL MAP OF  
WESTERN FRANKLIN  
COUNTY AND  
ADJACENT DECATUR  
COUNTY, SHOWING  
THE BOUNDARY  
BETWEEN THE UPPER  
AND LOWER  
SILURIAN ROCKS.

By AUG. F. FORREST.

(Scale, 2 miles to the inch.)



Anderson Falls.—A mile south of Long Falls, on Fall Fork, is Anderson Falls. The Waldron shale a short distance below the falls has furnished the best fossils found in this shale in Bartholomew County. Immediately above the shale the brown limestone which corresponds to the limestone already described from Long Falls is found. Near the sides of the stream bed, just above the falls, traces of corals are found, but these are not well enough preserved for purposes of correlation. The identification of the corals at Long Falls as Devonian makes it more than probable that the corresponding rock at Anderson Falls is of the same age. The 5 feet of rock above the Waldron again remain of uncertain age.

According to barometrical measurements the Clinton west of Benville lies 23 feet above the level of the railroad station at Old Vernon, or 722 feet above the sea.

The Waldron about 2 miles east of Old Vernon was 24 feet below Old Vernon railroad station, or 675 feet above sea level.

The Waldron at the Tunnel Mill was 65 feet below the Old Vernon railroad station, or 634 feet above sea level.

The Waldron at Benville was calculated as being due at 61 feet above present Clinton level, or 783 feet above the sea.

#### FRANKLIN COUNTY.

##### L. NEAR CAVE HOLLOW FALLS.

202.\* About three-quarters of a mile east of the county line, and north of the road, north of the railroad, is a quarry opened in the Lower Silurian, which is worked chiefly for crushed stone. The limestone at the top of the Lower Silurian is here quite solid, and has a white color; in places it is nearly 20 inches thick. A little salmon-brown Clinton is seen.

206. Going from Larkin Walter's quarry, in Decatur County, a quarter of a mile eastward, and then a mile northward, a good exposure of Clinton is seen at a little fall, near a road corner. The Clinton is here 7 feet thick; it has a salmon-brown color, and rests on white Lower Silurian rock. The Osgood beds beneath the soapstone layer are about  $8\frac{1}{2}$  feet thick. The soapstone is about 24 inches thick.

207. A third of a mile northward the Cave Hollow Falls expose a somewhat larger section.

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\*The numbers refer to numbered localities on the accompanying maps.

*M.* BUENA VISTA AND VICINITY.

208. A mile west of Buena Vista, Bull Fork, a branch of Salt Creek, is crossed by the east and west road. The Clinton is here at least three feet thick, and probably does not exceed three and one-half feet at this point. Its color is reddish or reddish-brown, but not salmon-colored.

209. A mile east of Buena Vista, and nearly three-quarters of a mile south of the county line, the Clinton is exposed in Long Branch; its color is salmon-brown, and it rests on nodular white limestone material. Beneath this is the heavy dark-blue limestone layer, which, near St. Maurice, shows the wave markings.

210. Half a mile directly eastward, in the bottom of another branch of Salt Creek the salmon-brown Clinton is seen to be about five feet thick.

212. Little Salt Creek.—Two miles north of Buena Vista the south fork of Little Salt Creek exposes at least two and one-half feet of Clinton. The Clinton contains *Rhinopora frondosa* and other characteristic fossils, but its color is not salmon-brown, the usual color of the Clinton in this part of the State. The Clinton rock is bluish; similar to some coarser grained Lower Silurian rocks.

211. Two and a half miles east of Buena Vista, where the road turns northeastward, a small branch of Little Salt Creek exposes a little salmon-brown Clinton.

*N.* BULL TOWN.

213. Senior's Quarry.—South of Bull Town, two miles southeast of Andersonville, and four miles west of Laurel. The quarry is found on the western side of Little Salt Creek, along a small tributary stream, an eighth of a mile south of the collection of houses known as Bull Town. At the quarry only the Laurel formation is exposed, but farther down the stream the Osgood formation is seen. The Osgood beds are again exposed on the eastern banks of the creek opposite the entrance of the stream. The Clinton and the upper part of the Lower Silurian are found just beneath. The measurements of the Clinton in the following section were taken from the creek locality.

<i>Stripping.</i>	{ 5 feet.	
	{ 4 inch layer.	} Of no account, commercially.
	{ 4 inch layer.	
	{ 4 inches, much chert.	
	{ 3 inch layer.	
	{ 8 inch layer.	
	{ 2½ inch layer.	} The best layers of quarry rock.
<i>Laurel Limestone.</i>	{ 5 inches with chert.	
	{ 4½ inch layer.	
	{ 7 inches. Spotted calc.	
	{ 5 inch curbing.	
	{ 2 inch flagging.	
	{ 8 inch curbing.	
	{ 1 inch layer.	
	{ 6 inch curbing.	
	{ 3 inch layer.	
<i>Lower Quarry or Osgood Rock</i>	{ 7 inch layer.	} Not worth much.
	{ Clay bed, not exposed, about 1½ feet thick.	
	{ 7½ to 8 feet of limestone, poor quality.	
<i>Clinton Limestone.</i>	{ 3 feet 2 inches thick; salmon-brown above, more pink or light-red below.	
<i>Lower Silurian.</i>	{ Blue clay of the type known as cement rock at the Derbyshire falls; 8 feet thick, with very even and fine grain.	

In the Clinton were found *Orthis calligramma* and *Heliolites sub-tubulatus*.

214. Bull Town Locality.—At Bull Town where the State road crosses Little Salt Creek, the Clinton is exposed in the creek bed north of the bridge. The Clinton contains a few pebbles of a greenish clayey, fine-grained rock, resembling, lithologically, some of the rock known as cement rock in the neighborhood of Laurel. The cement rock occurs in the upper part of the Lower Silurian, but stone of a similar character occurs also as layers and lenses in the Clinton itself in this neighborhood; making it probable that the material for the pebbles was derived from the Clinton layers rather than the Lower Silurian. The largest pebbles were three to four inches long. Quarries of Laurel limestone rock occur farther up, for half a mile on both sides of the stream.





DERBYSHIRE FALLS, FRANKLIN COUNTY, IND.

The top of the Lower Silurian is very argillaceous; from the base of the Clinton to the pool at the foot of the falls is a vertical height of 32 feet. The total height of the falls is about 40 feet.

219. About three-quarters of a mile down the valley from Derbyshire Falls, a deep valley enters from the north. At the angle made by these valleys, high up on the cliff, the Clinton is well exposed. Beneath the Lower Quarry or Osgood beds is a rather fine-grained, crinoidal rock, whose position is doubtful. It is one foot six inches in thickness. The Clinton is five feet three inches thick. Its color is red or reddish brown, and the limestone contains layers and lenses of argillaceous rock.

#### P. BRANCHES OF LITTLE SAIN'S CREEK.

220. Chris. Mead's Quarry.—Located two and a half miles southwest of Laurel, on the Little Sain's Creek road, and then half a mile southward up a branch of the creek. The Clinton is exposed a little distance beyond the junction of two small branches of the stream. It is six feet six inches thick; the upper part is salmon-brown in color, the lower is reddish. The fossils observed are: *Illænus daytonensis*, *Calymene vogdesi*, *Plectambonites transversalis*, var. *elegantula*, *Strophomena* (*Orthothetes*) *hanoverensis*, *Leptaena rhomboidalis*, *Atrypa marginalis*, var. *multistriata*, *Orthis calligramma*, the form found at Hanover, *Clathropora frondosa*, *Pachydietya rudis*, *Hemitrypa ulrichi*, *Phylloporina angulata*, *Heliolites subtubulatus*, *Favosites venustus*, *F. favosus*, *Halysites catenulatus*, *Cyathophyllum daytonense*.

The Lower Quarry rock was exposed, but its thickness was not measured. Judging by the neighboring exposures, it does not exceed six feet six inches.

The lower part of the Laurel bed is quarried northeast of the Clinton exposure. Beginning with the base of the formation, the following layers are found: Six inches and then three inches of poor, soft rock, known locally as the underground ledges. Good quarry stone as follows: Five, four, six, four, five, six, two and four inches; the spotted calf layers, formed by a six-inch layer, followed by two inches of chert and six inches of limestone; then less valuable rock, used chiefly for flagging, as follows: Four, three, three, five, five, five, two and two inches of chert; two, two, three and one inch of chert; three, two, three and four inches of chert, and six feet of stripping.

Immediately below the Clinton is blue shaly clay, with typical loose Cincinnati group fossils within several inches of the Clinton.

221. D. L. Secrist's Lower Quarry.—Located a quarter of a mile

north of Chris. Mead's quarry, at the head of another gully, is an old, abandoned quarry formerly worked by D. L. Secrist. It lies south of the southern branch of the Little Sain's Creek road. The upper salmon-brown portion of the Clinton is exposed at the lowest point in the quarry.

Overlying the Clinton is the Lower Quarry or Osgood rock, which here is six feet six inches thick. In general it is a bluish rock, occurring in rather massive layers, which, however, go to pieces rather readily under the influences of weathering. It is a very argillaceous limestone, containing at various levels considerable crinoidal material, which gives it a lithological appearance very much like that presented by the Osgood beds at the New Point quarries. Measured from below upwards, the following section is presented: Four inches of drab-colored limestone, considerably resembling the basal Niagara of more southern sections; 26 inches of stone which often come out together, but which usually separate into the following layers: Ten, three, three, three, three and five inches; twenty inches of rock, which usually separate into nine and ten-inch layers; fifteen-inch, six-inch and seven-inch layers; the latter forming the top of the Osgood section.

Above the Osgood bed is a twenty-inch layer of blue clay, which is the very characteristic parting between the Osgood bed and the Laurel limestone of these regions, and which is known as the soapstone ledge farther southward. It lies near the top of the Osgood beds.

222. Harrison Crowell's Quarry.—Two and a half miles southwest of Laurel, just before reaching a fork of the Little Sain's Creek road, a branch enters the creek from the south. Nearly a mile up this branch, just east of the township line, is the quarry of Harrison Crowell. The Clinton is exposed a short distance down stream. Over it lies the Lower Quarry, a part of the Osgood rock; its thickness is 11 feet 6 inches; it is not quarried. A bed of blue clay or soapstone is seen near the top of the Osgood bed, above the Lower Quarry rock. The base of the Laurel limestone is locally known as the underground ledge; it is a bluish stone, of variable quality, so that it is sometimes quarried for curbing, and sometimes considered as inferior stone. At the Crowell quarry it is quarried; it consists of several layers, in ascending order: Seven, six and two and one-half inches thick. The succeeding layers, five, five, two, four, six, two and six inches thick, form the best curbing stone of the quarry. They underlie the spotted calf layer, which shows the usual chert nodules; it is formed by three, three and one-half and two-inch layers, the middle portion composed chiefly of chert. The overlying courses are interbedded too often with chert to be a very valuable part of the quarry, and any rock found



available in this section is considered so much clear gain by the quarrymen. The following gives the thickness of the courses in ascending order: Four inches with chert nodules, two layers three and four inches thick, often clinging together; two inches of chert, three inches of limestone with chert nodules; three, three, two, two and two inches of limestone, the last layer with chert. The layers above the spotted calf are used chiefly for flagging. The stripping over the rock amounts to about three feet.

223. A short distance down stream, on its southern side, the Clinton is 34 inches thick. The upper part has a salmon-brown color, the lower part is reddish. The lower part of the Clinton contains rounded fragments of *Heliotites*, of brownish, fine-grained siliceous Clinton rock, and of a greenish rock which very much resembles the upper part of the Lower Silurian rock just beneath the Clinton, where it is hard and very argillaceous. Rock of this kind, however, occasionally occurs interbedded with the normal Clinton in some places, so that the origin of these pebbles can not be conclusively determined. The following fossils were found in the Clinton: *Orthis calligramma* with many plications, *Heliotites subtubulatus*, *Halysites catenulatus*, *Oyathophyllum daytonense*, and *Ptychophyllum ipomea*, several specimens.

Below the Clinton are four to five inches of solid dark-blue rock, underlaid by soft greenish clay.

224. An eighth of a mile down stream from Crowell's quarry, near a quarry on the south side of the stream, at the head of a little gully the Clinton is exposed. It is three feet six to ten inches thick, has a salmon-brown color above, and is reddish below. The basal Niagara, with its drab color, directly overlies it.

225. Harry Manly's Quarry.—About half a mile east of the township line, on the northern side of Little Sain's Creek, is Harry Manly's quarry. A good detailed section of the rock was obtained at this point, which is given here in descending order.

*Stripping.* { 12 feet of clay and a little rock.

<i>Laurel Limestone.</i>	{	5 inch cheap yellow flagging or curbing.	Chiefly used for rubble and lower grade stone work in general.
		2 inch stone.	
		2½ inches of chert.	
		3 inch stone.	
		4 inch stone.	
	{	3½ inch stone.	
		3½ inch layer, with chert nodules in lower part.	
		6 inch layer, with chert nodules in upper part.	
		4½ inch, good flag or curbing.	
		4½ inch spotted calf layer, with chert nodules in upper part, used for ditch stone and gutter flag.	

<i>Laurel</i>	{	3 inch flagging.	
		6 inch curbing.	
<i>Limestone,</i>	{	2 to 2½ inch light cellar flag.	
<i>Continued.</i>		8 inch layer, used for 6 inch curbing.	
		7 to 9 inch layer used for curbing and steps or sills.	
<i>Lower</i>	{	7 to 9 inch layer used for curbing and steps or sills.	
<i>Quarry Rock</i>		1 foot of soft blue clay, locally known as soapstone.	
<i>or Osgood</i>		14 inches.	
<i>Bed.</i>		22 inches, capping into	These layers though thicker are never quarried.
		3 layers	
		3 feet 6 inches of thin layers of soft limestone, not quarried.	
<i>Clinton</i>	{	3 feet 8 inches of limestone, salmon brown above, reddish below.	
<i>Limestone.</i>			
<i>Top of</i>	{		
<i>Lower</i>		4 feet of soft blue clayey material, with a hard, 6 inch layer, 6 inches below the Clinton.	
<i>Silurian</i>			
<i>Rock.</i>			

226. A. W. Cloud's Quarry.—Located about half a mile northwest of Manly's quarry, at the head waters of Little Sain's Creek, just east of the township line. The following detailed section describes the rocks in descending order:

<i>Stripping.</i>	{	4 feet of clay and rock.	
		7 inches for street crossings, foundation footings and gutters.	
		2 inches.	Not useful except for crushed stone.
		6 inches.	
		3 inches.	
		3 inches.	
		3½ inches.	
		2½ inches of chert.	
		4 inches for flagging and street crossings.	
<i>Laurel</i>		2½ inches.	Sometimes grown together, used for street crossings.
<i>Limestone.</i>		2½ inches, cherty.	
		3½ inches, cherty.	Sometimes holding together, used for street crossings.
		4½ inches.	
		4½ to 5 inches, for crossings and gutters.	
		5 inches with chert.	Sometimes holding together, used for foundations for heavy buildings.
		7 inches.	
		2 inches of chert.	
		4 inches, street crossings and gutters.	Too hard for curbing.
		5 inches, street crossings and gutters.	
		4 inches, street crossings and gutters.	
		5 inches.	Often holding together; spotted calc; used for 2 crossing stones or 1 foundation stone.
		5 inches.	

<i>Laurel Limestone, Continued.</i>	{		5 inches; first cut ledge, for curbing.	
	{		3 inches; ragged layer, for gutter stone.	
	{		4 inches.	} Often holding together, used for steps, water tables, building stone and heavy curbing.
	{		6 inches.	
	{		2 inches, for grave covers and light flagging.	
	{		6 inches, for curbing and gutter.	
	{		8 inches.	} Often holding together, used for curbing. "Underground" courses.
	{		4 inches.	
	{		5 inches, for curbing.	
	{		1 foot of soft blue clay, locally known as soapstone.	

The Lower Quarry or the rest of the Osgood stone bed is exposed farther down stream.

227. A. W. Cloud's Old Quarry.—Directly north of the quarry last described, across a low ridge, is another quarry, also worked by A. W. Cloud, but only to a small extent. It is situated at the head of a northern branch of Little Sain's Creek. The quarry is opened in the Laurel limestone.

228. D. L. Secrist's Quarry.—A short distance east of the last quarry is one of Secrist's quarries. The Laurel stone here exposed is more brown than usual. The following section is here exposed:

<i>Laurel Limestone.</i>	{		Stripping.	4 feet.	
	{		2 inches of chert.		
	{		3 inches.		
	{		4 inches.		
	{		5 inches.		
	{		3½ inches.	} For flagging.	
	{		3½ inches.		
	{		3 inches.		
	{		4 inches.		
	{		3 inches.		
	{		6 inches; spotted calf layer.	Street crossings.	
	{		2½ inches.	} Flagging.	
	{		2½ inches; ragged layer.		
	{		8 to 10 inch; for stairs; sometimes splitting up into 6 and 4 inch layers, then used for curbing.	} Used for highest grade curbing.	
	{		3½ inches.		
	{		4 inches; bottom ledge.		
	{		4 inches.	} Underground courses, used for lower grade curbing.	
	{		6 inches.		
	{		5½ to 6 inches.		
<i>Osgood Beds</i>	{		Soft blue clay, not measured.		
	{		Lower Quarry or the rest of the Osgood beds; not measured, but about 6.5 thick.		
{		<i>Clinton Limestone.</i>	30 to 36 inches thick.		

The Clinton is not well exposed; it occurs in the bed of the stream about 100 feet west of the quarry. The fossils were *Clathropora frondosa* and *Halysites catenulatus*.

229. About a quarter of a mile down stream, on the southern side of the stream, the Clinton is 40 inches thick.

230. D. L. Secrist's Quarry.—About two and one-half miles southwest of Laurel, the Little Sain's Creek road forks; a short distance east of the fork is a stone schoolhouse. From this point a road leads up to a quarry on the very summit of the ridge north of the creek. This is another of D. L. Secrist's quarries. The following is a section of the rock here exposed:

<i>Stripping.</i>	{	7 to 10 feet.
<i>Laurel Limestone.</i>	{	6 inch layer, brown.
		6 inch layer, brown.
		3 inches of chert.
		3 inches of chert.
		8 inches, gutter culvert covering stone.
		6 inches, with a little chert; gutter and street crossing stone.
		7 inches; spotted calf layer; with a little chert.
		5½ inches; curbing.
		3 inch flag.
		6 inch curbing.
		4 inch curbing.
		2 inch flagging.
		5 inch curbing.
		5 inch curbing.
}	Often together, requiring capping.	
{	8 inch curbing.	
	6 inch curbing.	
{	The "Underground" layers.	
	7 inch curbing.	
{	20 inches of soft blue clay.	
	Lower Quarry or the rest of the Osgood beds; 4 feet 6 inches, total.	
<i>Osgood Beds</i>	{	
<i>Clinton Limestone.</i>	{	25 inches of salmon brown stone.

#### Q. DRY BRANCH.

231. Dry Branch Quarry.—Located south of the road two miles northwest of Laurel. The Clinton is here 11 inches thick. It is bluish in color, with salmon-brown crinoidal spots intermingled, varying in places to a general salmon-brown tinge, not as marked, however, as in the case of the more southern exposures. In places it has a light-red tinge spotted with salmon-brown specks. The fossils are:

*Orthis calligramma*, the form found at Hanover; *Orthis elegantula*, *Pachydietya bifurcata*, *P. obesa*, *P. turgida*, *Rhinopora verrucosa*, *Heliolites sub-tubulatus*, *Favosites favosus*, *F. niagarensis*, *Halysites catenulatus*, *Cyathophyllum celator* var. *daytonense*, and a large specimen of *Ptychophyllum ipomea*.

Overlying the Clinton are five feet six inches of the Lower Quarry or Osgood rock. It consists mostly of thin layers of drab or light-brown limestone, traversed by many vertical seams, so that it is not quarried. The lowest layer is quite hard, lies directly on the Clinton, and resembles the basal Niagara of more southern sections. The Laurel bed consists of bluish limestone. The first marked chert layer occurs five and one-half feet above the base of the Laurel bed; it is the spotted calf of this region. The layers below this chert bed are the layers of Laurel rock chiefly quarried. Above the spotted calf layer the Laurel section contains chert layers at distances of six to ten inches apart, for a thickness of about five feet.

Below the Clinton is a bed of blue clay twenty inches thick. Beneath is a four-inch layer of limestone; its color is blue, varying towards brown; sometimes it has a salmon-brown color, which is confusingly like the Clinton in lithological appearance, although containing the usual Lower Silurian fossils: *Rafinesquina alternata*, and *Orthis* (*Hebertella*) *occidentalis*. Below this are six feet of soft blue clay, with some thin limestone layers, twenty feet of blue limestone, with many fossils and interbedded with clay layers, and four feet of blue clayey shale.

232. Reiboldt's Cave or Falls.—Half a mile south of the Dry Branch quarry, on the west side of the branch, a side stream enters from the Reiboldt farm. A short distance up this stream is a fall formed by the projecting Clinton rock; the Lower Silurian clayey rock immediately below has been washed away so as to leave quite a cave beneath the Clinton, whence the name. The Clinton is seven feet two inches thick; its color is salmon-brown above and light red or pink below. About one foot of soft blue clay overlies the Clinton. The drab basal Niagara immediately above forms the base of the Lower Quarry rock of this region.

Below the Clinton are five feet of Lower Silurian blue clay; eight feet of fossiliferous limestone, two feet of blue clay, four feet of fossiliferous limestone, and two feet of blue clay, perhaps only in small part exposed.

*Halysites catenulatus* was found in the Clinton.

*R. BIG SAIN'S CREEK AND BRANCHES.*

233. John Deis' Locality.—Half a mile southwest of Reiboldt's Cave is the house of John Deis. Northwest of the house, immediately west of the road, the Clinton is 32 inches thick; its color is reddish or pink, not salmon-brown. It contains *Favosites niagarensis*, *F. venustus*, and *Cyathophyllum daytonense*. Below the Clinton are four inches of Lower Silurian blue limestone, with *Orthis (Hebertella) occidentalis*.

A short distance northwestward a small stream exposes the Clinton again; it is here only 22 inches thick.

234. Immediately south of the house only 12 to 16 inches of the Clinton are exposed, although the total thickness of the Clinton at this point may be somewhat greater.

235. John Bower Locality.—The stream west of Deis' house flows southward and empties into Big Sain's Creek. Half a mile up the creek, a short distance below John Bower's house, on the north side of the creek, near the head of a gully, is an exposure of the Clinton, four feet four inches thick. Its color is between salmon brown and reddish, and it is strongly crinoidal.

A hundred feet farther southward the Clinton is only three feet thick. The upper ten inches are of a good salmon-brown color; the middle and lower parts are fine-grained, not crinoidal; the color is reddish brown; characteristic Clinton fossils are common.

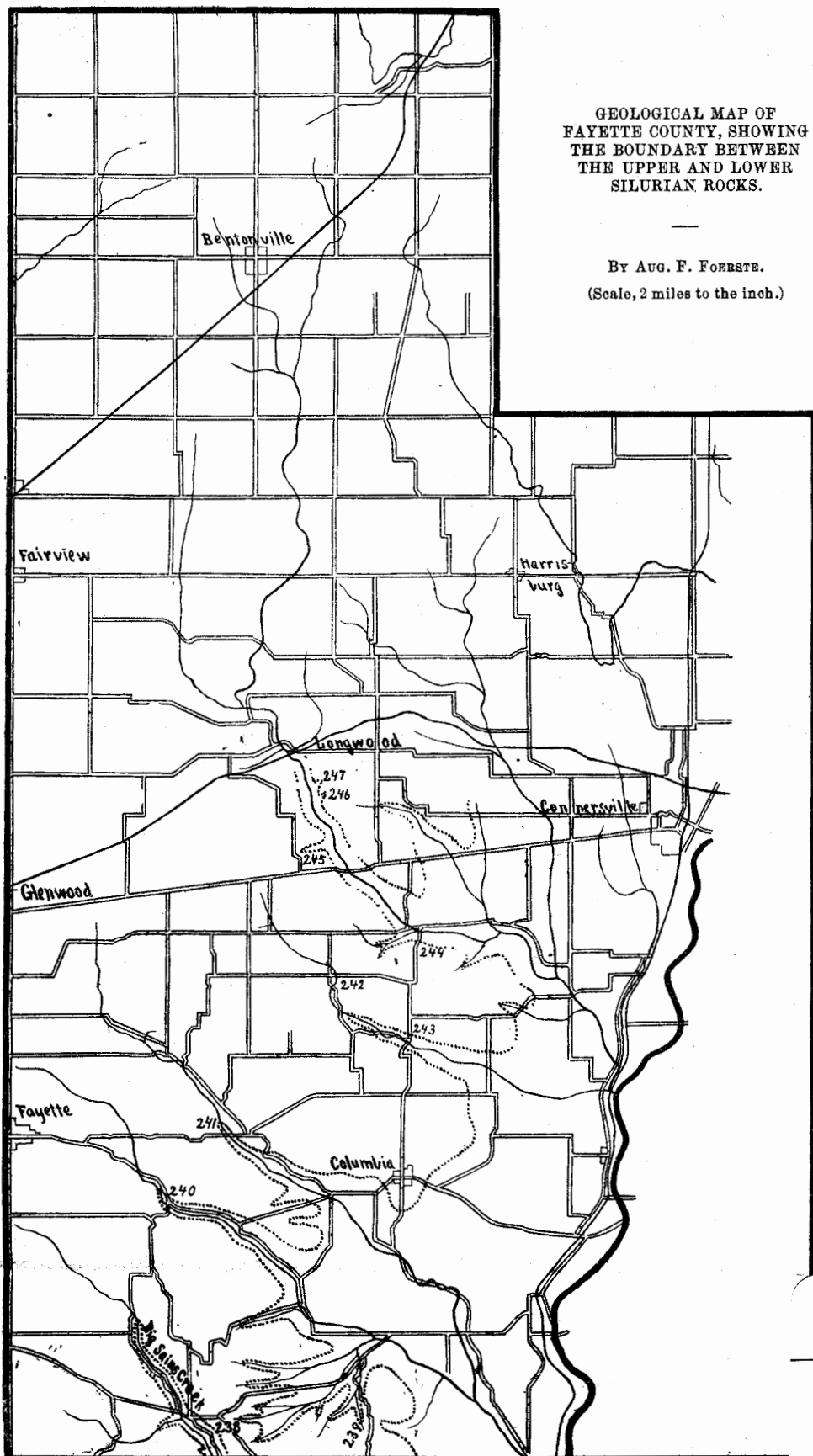
236. Daly Adams' Quarry.—Two miles up the creek, about four miles west of Laurel, on the north side of the creek, just before reaching the next north and south road, is the quarry of Daly Adams. The Clinton is here four feet four inches thick; its color is salmon brown. The Lower Quarry or Osgood rock is ten feet six inches thick, and is composed of thick layers, which are not quarried. At least four feet of the Laurel bed are quarried.

The upper part of the Lower Silurian is formed by quite solid argillaceous rock, about two feet thick, underlaid by about twelve feet of blue shaly clay, and this in turn by several feet of hard but thin argillaceous limestone.

237. Half a mile farther up stream, just south of the county line, on the east side of the creek, the Clinton is 52 inches thick. Its color is reddish brown; it is a siliceous limestone, quite different from the Clinton most typical of the Laurel region. Below the Clinton are four feet of hard blue clay.

GEOLOGICAL MAP OF  
FAYETTE COUNTY, SHOWING  
THE BOUNDARY BETWEEN  
THE UPPER AND LOWER  
SILURIAN ROCKS.

By AUG. F. FOERSTE.  
(Scale, 2 miles to the inch.)



## FAYETTE COUNTY.

## S. SOUTHERN PART OF THE COUNTY.

238. Big Sain's Creek Locality.—About five miles northwest of Laurel, in Franklin County, the road reaches Big Sain's Creek, a short distance south of the county line. At this point the road turns northward and skirts the eastern bank of the creek for half a mile northward. Exposures of the Clinton are rather common as far north as the church. It is 34 inches thick and has a reddish color. It is fine-grained where siliceous, and coarsely crinoidal where distinctly red and not siliceous. Lithologically the Huston quarry Clinton is intermediate between this rock and the Clinton as exposed southwest and west of Laurel. At the present locality the Clinton includes pebbles, lenses and layers of a bluish, more fine-grained rock. The pebbles are therefore derived from rock of Clinton age.

239. J. N. Huston's Quarry.—About two miles northwest of Laurel, in Franklin County, the road crosses Dry Branch; from this point a road passes northward into Fayette County. A quarter of a mile north of the county line, where the road begins to descend the hill, a quarry is seen in the fields west of the road, quite a distance from the same. The Laurel formation is here quarried. The Clinton is exposed at the lower end of the quarry, in the former bed of a small stream. It is four feet six inches thick; its color is intermediate between salmon brown and a bluish-brown color, specked with small reddish-brown spots.

About a mile north of Locality 238, just east of the township line, on the road going northeastward along the little creek is Thomas's quarry, the last quarry opened in the Laurel limestone within reasonable distance of the Laurel area.

## T. FAYETTE TO COLUMBIA AND NORTHWARD.

240. Two miles southeast of Fayette, along the northern side of the creek, about twelve inches of pinkish Clinton are exposed. The total thickness may be considerably greater.

241. A mile northeastward and over two miles directly eastward of Fayette a better exposure is seen. The top of the Lower Silurian is composed of blue shaly clay, and at least nine feet are exposed above the bed of the creek. The solid Clinton limestone is 20 inches thick. Its color is chiefly reddish, but salmon-colored tinges are recognized



here and there. Near the top it contains a few streaks of bluish clay. Directly over the more solid Clinton is found an alternating series of thin limestone and blue clay layers having a total thickness of 18 inches. Although quite unlike the usual appearance of the Clinton elsewhere, these layers are undoubtedly to be classed with the Clinton, and suggest that its total thickness is here about three feet. At Locality 240 these upper layers of the Clinton were probably also present, but were not seen.

243. A mile and a half north of Columbia, Lower Silurian fragments occurred in the gravel of the creek bottom.

242. A mile up stream from Locality 243 the lower Laurel limestone is exposed. The limestone layers are here quite thin, similar to those at Longwood. The Clinton level must lie somewhere between localities 242 and 243.

#### U. VICINITY OF LONGWOOD.

244. Three miles directly north of Columbia is found the lower portion of the creek which causes the exposures near Longwood. Lower Silurian strata could be detected even in the highest exposures on the hillsides south of the creek.

245. At Ochiltree's quarry, over a mile south of Longwood, on the road west of the creek, the Clinton can not be readily distinguished from the associated rocks, although its general position can be readily determined. The thickness of the Clinton has been recently determined with considerable exactness at the Longwood quarries, and no doubt it is practically the same at Ochiltree's quarry.

The Laurel limestone is quarried here at present to a moderate extent, but more than at all the quarries at Longwood.

246. Ball's Quarry.—At Longwood, five and a half miles west of Connersville, is Ball's quarry, located a quarter of a mile below the railroad crossing, on the eastern side of the stream, at the head of a short gully. The Clinton is here four feet thick; its color is reddish brown; the stone is rather fine-grained for Clinton rock, and is a quite siliceous limestone. It is very difficult to distinguish in some places from the immediately overlying Niagara limestone. The fossils recognized are: *Orthis flabellites*, *Leptaena rhomboidalis*, an obese form of *Atrypa marginalis*, *Phylloporina angulata*, *Pachydietya rudis*, *Rhinopora verrucosa*, *Heliolites subtubulatus*, *Striatopora flexuosa* and *Halysites catenulatus*. Immediately above the Clinton, at the quarry, is found a six-inch bed of soft blue clay; this bed is not seen at some of the exposures farther north. Above the clay are six feet of brownish limestone which are not quarried. This represents the Osgood

bed of Ripley County, or the Lower Quarry rock of the Laurel region. The lower layers of this bed are rather thick, but they are traversed by numerous seams which destroy their value as a quarry rock. The upper layers are thinner, not exceeding four inches in thickness; but they are also discarded by the quarrymen. The fossils seen came from the lower layers of the Osgood bed, and consisted of a species of *Orthoceras* and *Atrypa reticularis*.

The layers which are quarried are assigned to the Laurel horizon. Measuring from the lower layers upward, the following courses are found (all the measurements are in inches): Four, two, poor; four, one, one and one-half, two and one-half, three, two and one-half, one, poor; three, one and one-half, two and one-half; four inches of limestone, including numerous chert nodules, probably the equivalent of the spotted calf layer of the Laurel section; two and one-half, poor; two, poor; one and one-half, one and one-half, one and one-half, one and one-half, one, one and one-half, one; four inches of cherty limestone, one and one-half, three inches. It will be noticed that most of the layers are very thin. The surface is very uneven, and evidently was formed in rippling water. The rock is suitable chiefly for flagging and rubble. Some flags of considerable dimensions have been removed from the quarry.

Below the Clinton are the upper layers of the Lower Silurian. In descending order the following is the section exposed: Forty-five inches of blue argillaceous rock, softening to blue clay, with a four-inch layer of hard rock near the middle; five inches of blue limestone weathered to rusty brown; 24 inches unknown; 28 inches of limestone and argillaceous rock interbedded; six inches of blue argillaceous rock with worm borings; 10 inches of bluish-brown limestone; 44 inches of hard blue clay, breaking up in irregular masses; 60 inches of rock, more like brown argillaceous rock above, but a hard limestone below; five inches of hard reddish-brown limestone, with abundant chert material included; 43 inches of argillaceous and siliceous limestone, of brown color.

247. On a former visit to this region, one of the more northern openings along the eastern side of the stream was better exposed; the rock most quarried was evidently that part of the Laurel bed below the spotted calf. It is there accredited as being four feet thick and probably included a part here included in the Lower Quarry rock. The spotted calf chert bed was two inches thick; above this lay 15 inches of good flagging stone, three of chert, 13 of rock, one of chert, and 12 of rock; followed by a mass of loose chert, evidently the accumulation of several layers, the intermediate limestones having been disintegrated.